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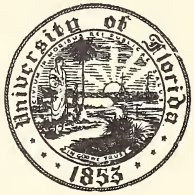

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Text 205 pages, 66 figures in the text, 5 plates.

ACTA GEOGRAPHICA 16, N:o 1

ON THE PHYTOGEOGRAPHY OF THE SUBARCTIC HUDSON BAY LOWLAND

BY

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HELSINKI—HELSINGFORS 1957

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INTRODUCTION

During the summer of 1956, thanks to a generous grant from the *Arctic Institute of North America*, I had the opportunity to visit the phytogeographically interesting region west of James Bay and Hudson Bay. My trip was a part of the »Hudson Bay Lowland» project launched by the *National Museum of Canada* in co-operation with the *Ontario Department of Lands and Forests*. For the privilege to be invited to join this project I wish to record my gratitude particularly to Dr. *A. E. Porsild*.

I extend my cordial thanks to Mr. *W. K. W. Baldwin*, Botanist, who arranged all the practical details for my excursions in the area, to the foresters, who helped to carry out the program, particularly Mr. *Ellis Dreyer*, Cochrane, and to all others, colleagues and old friends.

The purpose of this paper is only to give a broad outline of the phytogeographical problems which can be studied in the area.

Helsingfors, May 15th 1957.

I. H.

GEOGRAPHICAL FEATURES OF THE SUBARCTIC HUDSON BAY LOWLAND

The general nature of the Subarctic Hudson Bay Lowlands has been well described in several papers, particularly by Coombs 1952 and 1954. Below I shall therefore try to omit unnecessary compilation of well known facts concerning the geology and geography of the area. Some preliminary remarks about the general features of the area must, however, preface any discussion of the flora and vegetation.

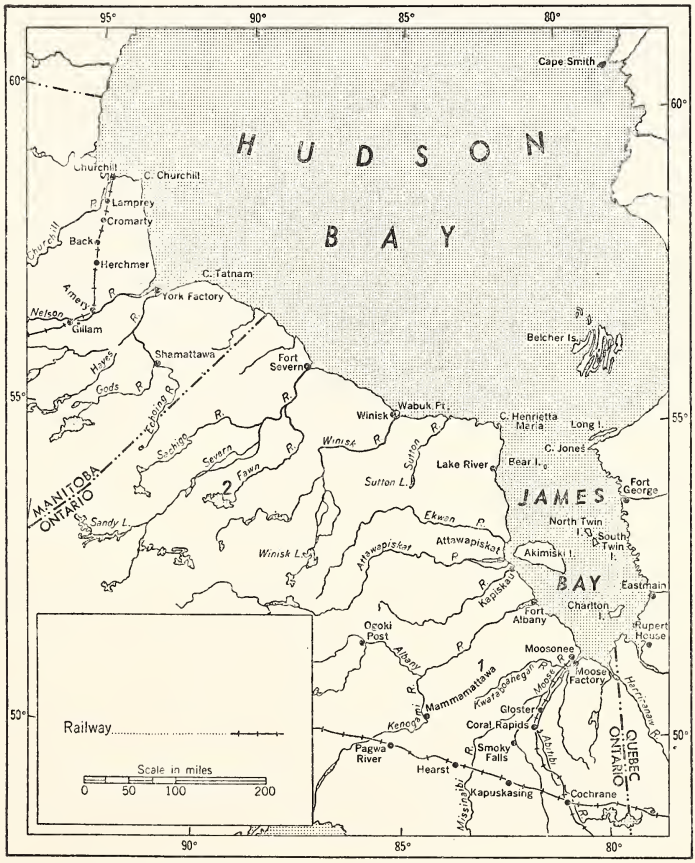
The concept »*Subarctic Hudson Bay Lowland*» is used here for the area shown in map 1 and 2. The full line on map 2 indicates the borders of the area submerged during the last glaciation, the broken line the border between the Precambrian and Palæozoic bedrocks.

Both lines on map 2 are important from a phytogeographical point of view, because they indicate areas with bedrock and primary soil conditions less acid than in the surrounding parts of the Canadian Shield. The submerged area stretches far to the north and to the east. A concept like the above, Subarctic Hudson Bay Lowland, if limited to the area inside the highest marine shore lines, would thus also include the east coast of James Bay and Hudson Bay. On the other hand, the expression »Hudson Bay Lowland» is already well established in the literature as a term comprising only the western and southern part of the coast. We have here a unique combination of an area with sedimentary bedrock and a submerged area in which crustal uplift is still taking place at the present time. The area lies south of the polar tree limit and thus within the Subarctic. North of the tree-line, on the west coast of Hudson Bay, the Lowlands extend as an earlier submerged plain far inside the Arctic proper. This northern part of the west Coast of Hudson Bay could be called the »Arctic Hudson Bay Lowland» with dominating tundra features.

The author delimits the region *Subarctic Hudson Bay Lowland* as indicated by the hatched area on map 2, thus using as western limits for the area a line combining both the western limit of the sedimentary bedrock and the western and southern limit of the submerged area. Thus edaphically the region is a

fairly homogenous area, especially considering the »smoothing» effect of the glacial till.

Climatically the area extends from temperate conditions in the south-westernmost part of the area, to more or less arctic conditions at Cape Henrietta Maria and Fort Churchill. There are not enough records to provide a discussion of the correlation of climate with vegetation. It should, however, be noted that, except in unusually cold years, places like the above-mentioned and also Winisk and Fort Severn are inside the often used 10° C isotherm, which over large areas coincides with the polar tree-line in Canada. Tree-ring records obtained during the field work at Fort Severn, 1956, indicate that the annual variations in tree growth, mainly due to the variation in the summer



Map 1. Location map of the area (acc. to COOMBS 1954). 1 = Sandback Lake, 2 = Big Trout Lake.

climate, are approximately of the same order as in the Labrador taiga (compare H 1955 and H 1956[1]).

A general impression of the humidity of the climate of this area compared with other parts of Canada is provided by SANDERSON's moisture index map (1950). This region belongs to a broad transition zone between the very humid

Map 2. The broken line indicates the area with Paleozoic bedrock, the full line the area submerged during and after the last glaciation. The shaded area is the Subarctic Hudson Bay Lowland. Regarding the letters a—d, compare p. 11.

[1]) The expressions H 1955, H 1956, etc. refer to the author's earlier papers, see references.

Fig. 1. Typical landscape just inside the share line, showing old beach lines (between Severn and Winisk). Small river cutting through beach lines (73 counted). Photo: Dr. A. E. Porsild.

eastern part of the Labrador peninsula and the dry climate of northwestern Canada. Considering the southern situation of the area, between the latitudes 50° and 60° north, the climate is raw and cold. On July 12, 1956, we could still see ice on the Bay a few miles from the mouth of the Severn and Winisk Rivers. The Severn River was free from ice on May 1, 1955, but in 1956 not until May 31. Around Fort Severn one finds ice in the bogs during the summer at a depth of 1—2 feet in the »palsas». Regarding permafrost in the region compare JENNESS' maps of 1949.

It seems that the occurrence of permafrost is not a widespread as one would expect. A rough idea of this southern limit is probably the occurrence

of »palsa-bogs» (see WENNER 1947, MOSS 1953, DRURY 1956, H 1939), which, in the author's opinion, mark the area with real permafrost.

Since the postglacial submergence (compare FLINT 1952 and LOUGEE 1953) the country has been slowly rising. According to several sources the crustal uplift has gone on recently at the rate of about 3 feet a century, but it seems to be much less in the southern part of James Bay, compare LOW's comparison of earlier maps of the Moose River delta (1912.)

The country is very flat. The slope from Big Trout Lake to the shore of Hudson Bay is about 4—5 feet to a mile, and from Sandbank Lake to James Bay only 2—3 feet to a mile. It is thus natural that the feature of greatest importance in the landscape is the more or less stagnant water, evidenced i.a. by the strong meandering of the small rivers and brooks.

The rivers dominate the morphology of the area, creating a great diversity of plant habitats. The rivers cut through the Paleozoic sedimentary bedrock and through layers of glacial till and clayey sediments up to 50—80 feet high; in some places where the river has recently changed its course, the stream cuts through deep layers of peat. The material is redeposited down the river on flats and slopes. Thus from time to time new habitats are created where different kinds of soil, organic and inorganic, are mingled. This means that along the rivers we have every opportunity to find a rich flora; this has been amply illustrated by the botanists exploring the big rivers in the area.

On the low shore of the sea, many factors are constantly at work, changing old habitats and creating new ones. Here, and particularly in the large deltas, glacial till and the river-born and marine sediments intermingle. The chemical qualities of the soil of such »new land» must differ from the older parts of the shore. For instance, the pH-values of these »new» soils that have emerged from the sea or been created along the lower parts of the rivers, are usually high. Judging from the vegetation pattern at Fort Severn alone, the main results of CROCKER and MAJOR (1955) soil development analyses of the invading pioneer vegetation on the bare areas newly created by retreating glaciers in Alaska, could also be applied to this recently created coastal strip along James Bay and Hudson Bay. Note also DUTILLY, LEPAGE and DUMAN 1954, p. 106. MOIR (1954) gives a short but adequate description of the vegetation on raised beaches of different ages.

Between the rivers the country is flat, boggy and marshy, or filled with lakes of different sizes. Gravel and sand formations, dunes, ridges and eskers are relatively uncommon, with the exception of the old raised beaches still seen far inland.

Fig. 2. Small meandering river coming in from west towards Fawn River. Note forested old river beds giving sufficient drainage. Photo: Dr. A. E. Porsild.

Dominant features of the terrain are the bogs and swamps inland between the rivers and the marshes on the coast. It looks from the air as if the river-banks are in some cases higher than the surrounding bogs (note also the description by WILSON 1912 of the Kapiskau River) because of the successively redeposited material and the activity of the ice in the spring, etc.

Compared with the surrounding Precambrian shield, the lakes are less numerous in this area and usually very shallow; on our reconnaissance flight this latter feature made it difficult to land even on very large lakes. The area on the other hand is (compare COOMBS 1954) tremendous rich in pools of every size.

Peat formation starts very near the sea shore. Only 1 or 2 miles from the high tide shores, one finds the beginning of peat accumulation on the marshy meadows of grass and sedge. About 5—6 miles from the mouth of the Severn River, we find peat layers up to 3 feet deep. If we consider the speed of the crustal uplift and the low gradient of the slope in the area (see above) such peat growth 5—6 miles from the shore should have taken about 600 years. Observations on the time needed for the formation of peat are scarce. HUIKARI

recently (1956 p. 39) compiled the information in the Finnish literature on the subject of the growth of peat; the values for annual peat growth on the surface vary between 1.2 and 33.5 mm. My observations from Canada, Knob Lake (H 1954) and Moose River (H 1955), using as approximate indicator the formation of adventitious roots of black spruce, point to a growth in thickness of the peat surface of 1/3 — 1/2 inches annually. The method was first applied (using pines growing in bogs) by BORGGREVE in 1889 (compare BACKMAN 1919 and SAARINEN 1933). It must be born in mind that Sphagnum grows differently in different habitats. There is, of course, also a difference between the Sphagnum species. The above-mentioned mean values of annual growth of peat do not represent the growth of Sphagnum-moss itself, which, of course, grows faster. But under the surface layer of living moss, the peat itself becomes denser under increasingly higher pressures. If this very tentative value of 600 years for the time needed for the formation of the peat layers at Fort Severn, is roughly correct, it implies an annual growth of peat of about 1.3 mm., which is not very far from the values mentioned in the literature from Finland.

Inland the peat layers are, of course, considerably thicker. At Sandbank Lake[1], the peat layers were at least 6 feet deep. MCINNES mentions peat layers 8 feet deep near Winisk (1908). On the other hand, we must consider the fact that the growth of peat does not take place evenly; the drying out of the peat, and likewise the activity of the permafrost, causes deformation. POTZGER and COURTEMANCHE (1954) made a radiocarbon-dating of a bog 18 miles east of Rupert House, i.e. near the east corner of our area. The age of a sample obtained from a 10-feet deep peat formation in a shallow lake, was 2350 ± 200 years. This means that the growth of the peat has been about 1.2 mm annually. This value correlates well with my observation from Fort Severn concerning the time needed for peat formation.

HUIKARI (1956) states that the maximal depth of peat near the Gulf of Bothnia in Finland on land which has been above sea level 500—1000 years is 85 cm, on land areas 1000—1500 years old, the maximal depth of peat is 135 cm, and land areas 1500—2000 years old about 250 cm. This last value (8—9 feet) coincides rather well with the above-mentioned values obtained by POTZGER and COURTEMANCHE (l.c.).

For investigations of this type the Subarctic Hudson Bay Lowland should afford admirable opportunities.

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[1]) Our reconnaissance party landed on this lake, July 10th 1956.

On map 2, we can distinguish the following roughly outlined areas with different inorganic soil structure, marked on the map:

a. Areas where the Palæozoic bedrock is overlain by glacial till and sediments from the submergence period (± peat).
b. Areas where the Precambrian bedrock is overlain by glacial till and marine sediments (± peat).
c. Areas with Paleozoic bedrock covered with glacial till (± peat).
d. Areas with Precambrian bedrock covered with glacial till (± peat), i.e. areas outside the Subarctic Hudson Bay Lowland proper.

If we consider the hypothesis, developed recently by Salmi (1955), that the underlying bedrock and sediments affects the vegetation through a considerable depth of peat, a classification of our area according to the above-mentioned scheme should be useful phytogeographically. Such a bedrock influence through deep peat and soil layers should be mirrored in the regional variation of bog and swamp formations. It seems that some areas are covered with thinner peat layers than others; the vast areas with tamarack fens (see below) seen in the interior probably indicate areas where the ground-water is more influenced by the underlying sediments or bedrock than in the surrounding bogs covered with poorer vegetation (Sphagnum species and dwarf bushes). The above classification, however, gives a good indication of the many possibilities afforded by the area for a closer study of the effect of the underlying bedrock on the recent vegetation.

From a phytogeographical point of view the following general characteristics of the Subarctic Hudson Bay Lowlands should be considered important:

The region lies inside the Subarctic in the boreal forest belt, if we use the polar tree-line as the southern limit of the Arctic proper (see map 10). Only a small area near Cape Henrietta Maria might be considered an Arctic outpost.

The region shows evidence of continuous crustal uplift, still going on, particularly in the northern part of the area.

The bedrock of the region consists to a large extent of sedimentary bedrock.

The region is low and flat; peat is the most prevalent soil type.

AN OUTLINE OF THE FLORA IN THE REGION

It is necessary to point out that before any real understanding of the vegetation of an area can be reached, we must have a sound basis of floristic knowledge of the area. Even a simple list of plants from an area tells us much about the productivity of the soils of a certain region.

It is possible to make a highly provisional list of the vascular plants growing in the Subarctic Hudson Bay Lowland. Of course, botanical exploration here was until recent time restricted only to the rivers and sea shores. But, as pointed out above, the rivers and shores, incl. their surroundings, provide a great diversity of habitats, and a closer examination of the vast areas between the rivers will probably not add many species to the list of vascular plants already noted from the area. But regarding the vegetation, the case is certainly the opposite; we shall not know our area at all until the vast areas between the rivers have been explored.

To get a preliminary floristic background of the area, we can start with a paper by DUTILLY, LEPAGE and DUMAN (1954) comprising a list of plants found in the James Bay *basin*. The authors thus also include species found only on the Precambrian shield outside the Subarctic Hudson Bay Lowland proper, see map 2. Such species are here omitted, compare below.

The authors have made extensive explorations, particularly along the Albany and Attawapiskat Rivers and on the shores of James Bay from Cape Henrietta Maria to Moosonee. But beside their own collections, they also include previous finds in the area as noted in the literature and in various collections. Their account can therefore well be used as a first floristic »reference book» from our area.

To gain a clearer taxonomic basis for our preliminary account of the flora in region, I have here omitted taxa of lower taxonomic value than *species*. Also all species found west of our region according to Dutilly et al. are here omitted. 669 vascular species belong to the flora of the Subarctic Hudson Bay Lowland proper if we restrict the material in DUTILLY et al. as proposed above. Of these species, however, about 40 must be considered as adventive plants or plants introduced by man in the past or in very recent time; most of these 40 species are marked as »introduced» in the paper mentioned.

To the remaining 629 species, we must, however, add at least 100 species not noted by DUTILLY et al. in the Subarctic Hudson Bay Lowland proper or found only north of the James Bay basin but still inside our region.

In a list of plants published as an appendix to my forest botanical notes (H 1955) from lower Moose River (Renison, about 30 miles south of Moosonee) the following 40 species are mentioned which do not appear in DUTILLY et al.

Lycopodium clavatum, L. obscurum, Dryopteris cristata, Schizachne purpurascens, Deschampsia flexuosa, Scirpus atrovirens, Carex pauciflora, C. angustior, C. Haydenii, Juncus tenuis, Trillium undulatum, Streptopus amplexifolius, Habenaria psychodes, Goodyera tesselata, Listera auriculata, Betula glandulosa, Stellaria palustris, Thalictrum dioicum, T. polygamum, Anemone virginiana, Clematis verticillaris, Parnassia caroliana (glauca), Ribes americanum, Amelanchier sanguinea, Viola nephrophylla, V. incognita, V. renifolia, Chimaphila umbellata, Gentiana crinita, Apocynum cannabinum, Euphrasia canadensis, Lonicera canadensis, L. hirsuta, Sambucus pubens, Campanula aparinoides, Solidago juncea, S. rugosa, Aster cordifolius and Senecio indecorus

Fig. 3. Luxuriant growth on a flooded terrace at Mammamattawa. We note ash and mountain maple in the foreground, elm in the background (the big tree). On the ground Pteretis pensylvanica. Photo: I. H. 1956.

During field work in 1956, just inside the southern border of Subarctic Hudson Bay Lowland, the following species not noted inside the Subarctic Hudson Bay Lowland according to DUTILLY et al. were found near Long Rapids, Mattagami River: Pinus Banksiana (see below), Taxus canadensis, Corylus cornuta and Clintonia borealis, e.g. species which, of course, really belong to the country south of the border.[1])

At Mammamattawa, about 40 miles south of the Forks at Albany River during a short stop on our flight on July 10, 1956, we collected the following species which are not mentioned in DUTILLY et al. from our area: Ulmus americana, Fraxinus nigra (already noted by BELL 1887), Asarum canadense and Osmorhiza sp. At Mammamattawa very good soil conditions (flooding and sedimentary bedrock) coincide with a temperate inland climate. At Sandbank Lake on our stop July 10 1956 i.a. Carex vesicaria and Eriophorum opacum were collected.

To these notes from the southern part of the region we must add the floristic work done along the Harricanaw River by DUTILLY and LEPAGE (1952). The lower Harricanaw is in the east corner of our area. The authors found many interesting species, but from their account it is difficult to make out which

[1]) Near the southern border of the Subarctic Hudson Bay Lowland at Long Rapids, Mattagami River, but not inside the region proper, i.a. Arceuthobium pusillum, Carex castanea, Astragalus canadensis, Oryzopsis pungens, Corydalis sempervirens, Epigaea repens, Monotropa uniflora, and many other species were collected in 1952 (cf. H 1955) and 1956; these species, however, are not regarded as belonging to our region.

species grow within the Subarctic Hudson Bay Lowland proper. At least Trillium cernuum, Panicum boreale and Carex Peckii from the lower Harricanaw should, however, be incorporated in the flora of our region.

North of the area dealt with by DUTILLY et al. there are a few collections, from Fort Severn, York Factory and Fort Churchill, which give additional information on the flora of our region. As mentioned above, DUTILLY et al. (1954) restrict their account to the James Bay basin proper. There might, however, be many more »new» species than those mentioned below, because, for instance, MOIR (1954) has done extensive botanizing along and near the Severn River 1951—53.

During my stay at Fort Severn 1956 the following 16 species, not mentioned by DUTILLY et al., were collected (the determinations made by Dr.A.E.PORSILD): Agropyron latiglume, A. violaceum, Carex brunnescens, Eleocharis uniglumis, E. palustris, Sisyrinchium angustifolium, Salix vestita, Urtica viridis, Melandrium affine, Drosera intermedia, Andromeda polifolia, Oxycoccus microcarpus, Epilobium latifolium, Primula incana, Pinguicula villosa and Taraxacum lacerum.

In 1950 SCOGGAN published an account of his collection in Manitoba from the northern part of the Subarctic Hudson Bay Lowland, near York Factory. It adds at least the following 8 species, Juncus Gerardii, Calamagrostis deschampsioides, Puccinellia distans, Arabis Holboelli, Descurainia sophioides, Gentiana acuta, Cicuta maculata and Veronica peregrina, to the flora of our region.

RITCHIE's list (1956) of native vascular plants collected by him and others at Fort Churchill includes the following 27 species which could be included in the flora of the Subarctic Hudson Bay Lowland: Lycopodium selago, Cystopteris Dickiaeana, Puccinellia langeana, Carex adelostoma, C. membranacea, C. rotundata, Luzula confusa, Salix alaxensis, S. arbusculoides, Melandrium Gillettii, Stellaria ciliatosepala, Anemone Richardsonii, Draba lactea, D. nemorosa, D. lanceolata, Saxifraga rivularis, S. caespitosa, S. oppositifolia, Fragaria glauca, Potentilla nivea, Loiseleuria procumbens, Arctous alpina, Euphrasia frigida and Erigeron humilis. This list adds a considerable arctic element to the flora of the region here discussed.

The points so far floristically explored in the area show the following number of native vascular plants: Renison at Moose River 301, Fort Severn 237 and Fort Churchill 270.

Adding the 104 species mentioned here to the list of DUTILLY, LEPAGE and DUMAN 1954, we can assume that the native vascular plants in the Subarctic Hudson Bay Lowland comprise at least 735 species, which amounts to a very rich flora, considering the climatic position of the region. The whole Canadian Arctic has a vascular flora of about 900 species and the large Arctic part of the continental Northwest Territories and Ungava about 650 species cfr. PORSILD 1955, p. 35).

A large number of the 735 species are calcicoles. The »oxylophytes» (sensu ST. JOHN 1922) of the Precambrian shield are in general not common species

(except the ordinary bog plants) in the Subarctic Hudson Bay Lowland and occur mainly on dry peat or in old forest soils in the area; many common oxylophytes are entirely absent. The shores and the river slopes provide habitats for species requiring a higher pH. The difference in this respect is more clearly seen when comparing in detail the species composition of two such edaphically different areas as Fort Severn, on the one hand, and Big Trout Lake, outside our region, on the other (cf. H 1957).

Owing to the fact that the region has only comparatively recently emerged from the sea, we cannot, of course, expect to find any *endemic* species in the area. But, after more detailed botanical research, we can probably find much material for a taxonomic study of the evolution of »microspecies» in several genera (compare, for instance the work done on Taraxacum, Hieracium, Ranunculus auricomus etc. in Europe).

One interesting point has been discussed by DUTILLY et al. 1954 (p. 10): »ce qui frappe — — — c'est de constater l'absence à peu près complète de Lycopodès et de Fougeres. Sauf de Botrychium virginianum var. europaeum — — — il nous a fallu remonter à 150 milles à l'intérieur pour récolter la première Fougère (Dryopteris disjuncta), alors que le premier Lycopode (Lycopodium clavatum) fut trouvé à 200 milles. La raison est peut-étre que l'emersion de la région est encore trop récente ou les habitats convenables trop rares». In the southern part of the area we find several ferns nearer to the coast (compare my notes from Renison, 30 miles inland from Moosonee, H 1955), but this point nevertheless illustrates well the scarceness of »oxylophyte» plants in the area. In this large region, using the sources available, see above, only the following ferns have so far been collected: Cystopteris fragilis, (C. Dickaeana), Dryopteris cristata, D. disjuncta, D. spinulosa and Pteretis pensylvanica and of these none is common. But just outside the area and at the southern border of the region we have several fern species: Cryptogramma Stelleri and Woodsia ilvensis at Long Rapids, Mattagami, and Polypodium virginianum at Coral Rapids (author's notes, 1956). Dryopteris thelypteris, Athyrium Filix-femina and Onoclea sensibilis occur at upper Albany (see DUTILLY et al. 1954).

Early in the modern phytogeography of North America two areas were particularly favoured by botanists: the Rockies, incl. the Pacific coast, and the Gaspé Peninsula and Newfoundland. Between these points of interest is the large Canadian Shield, with botanically rather »uninteresting» and only partly explored poorer habitats. To the less well explored region belong also the Paleozoic areas of Hudson Bay. But, nevertheless, several interesting phytogeographical hypotheses were developed, in spite of the fact that there was a great »vacuum» in the floristic exploration of Central Canada.

We recall, for instance, in this connection:

1. The refuge hypothesis developed by FERNALD 1925. The hypothesis is not entirely out of date, but the large material on which it was originally based has shrunk severely owing i.a. to WYNNE-EDWARDS (1937) and ROUSSEAU's work in, for instance, Mistassini (1953), and the explorations in the James Bay and Hudson Bay area.

2. POTTER's hypothesis (1932) on the supposed marine connection between the St. Lawrence basin and Hudson Bay during post-glacial time. This hypothesis is more or less out-of-date (compare PORSILD 1932 and BOIVIN 1954) because of accumulated floristic data.

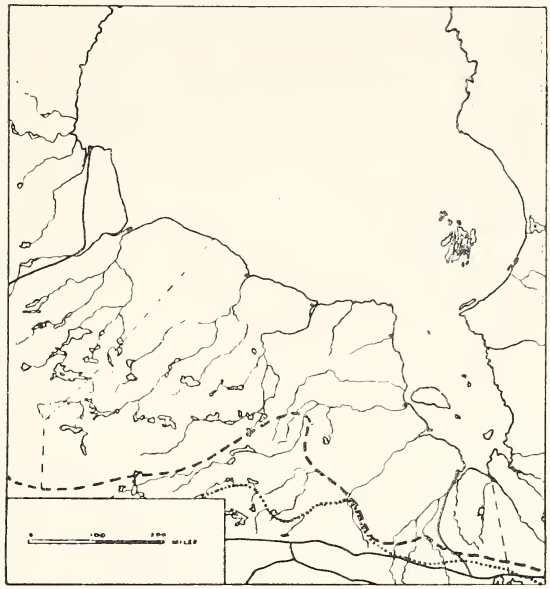
3. MARIE-VICTORIN's »rainbow» theory (1938) explains the occurrence of some »relict» species in eastern and western Canada. Some of these »relicts» also occur in the Subarctic Hudson Bay Lowland. There is certainly a positive correlation between too few field data and too far-reaching phytogeographical theories.

ON THE DISTRIBUTION OF TREE SPECIES IN THE REGION

The whole area, except Cape Henrietta Maria, lies inside the Subarctic or the »Forest-Tundra». The narrow coastal strip from Cape Henrietta Maria northwards is often included in the Arctic proper. If we use the polar tree-line of conifers as the southern limit for the Arctic proper, we can, however, exclude the above-mentioned coast from the Arctic, because, as could frequently be seen from the air, the spruce and tamarack goes down almost to the shore in small clumps or as isolated trees or bushes more or less everywhere along the west coast of Hudson Bay south of Fort Severn except Cape Henrietta Maria proper.

We could call a large part of our region from Attapapiskat northwards, an *edaphic forest tundra*, because it is not the climate itself which accounts for the scarcity of the forest, but the edaphic conditions prevailing there. The forest extends more or less down to the shore along the rivers and brooks, whereas treeless bogs, fens and marshlands occupy the vast areas between the rivers and on the shore.

To get a more adequate phytogeographical picture of the region, I have tried to map the distribution of the tree-species. It is unnecessary to point out that much more research is needed before the lines on map 3—10 will be more than rough estimates.

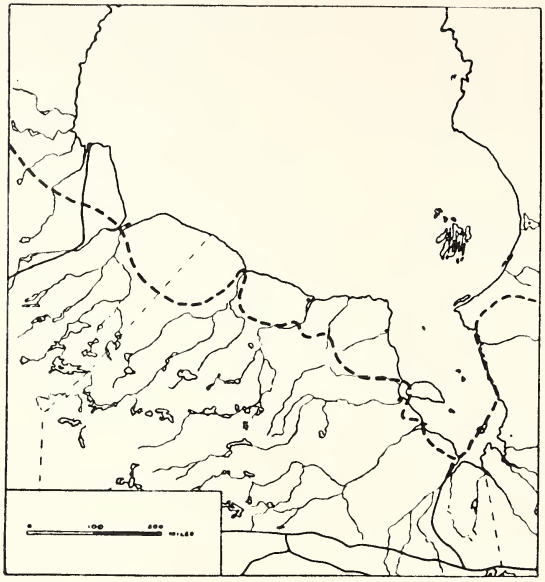


Map 3. A tentative map of the distribution of *elm* and *ash* (broken line) south and west of Hudson Bay. Based on Bell, Wilson, a.o. Both species avoid the submerged area.

Into the southwestern corner of our region two broadleaved tree species intrude from the south, the *black ash* (Fraxinus nigra L) and the *white elm* (Ulmus americana L.). Their distribution map is based mainly on Bell (1887), who reports ash from the upper Attawapiskat (Landsdowne Lake) to about the Streatfield River (l.c., p. 24 and 26) and elm from the Kenogami River. On Wilson's map (1903) elm is marked northernmost at the inflow of Current River into Kenogami 10 miles south of The Forks at Albany River. On our 1956 trip, we landed near Mammamattawa and found there well grown elms, up to 45—50 feet high and 20 inches d.b.h.; many young seedlings of elm and ash was also found here. It seems that elm occurs nowhere else in the region except along the Kenogami River. 1—2 miles below Long Rapids in Mattagami River black ash but no elm was observed in 1956.

We, thus, have an outlier of the »main tree-line» (sensu H 1949) in the SW corner of our region. In his regional site classification of Ontario Hills (1952) cuts out the southwestern part (»Kenogami») from the Hudson Bay Lowlands.

Aspen (Populus tremuloides Michx.) occurs on dry sites over more or less the whole southern part of the area. Dutilly et al. 1954 report aspen from



Map 4. A tentative map of the distribution of *aspen*. The species seems to avoid the coast except at the mouth of the larger rivers. Note occurrence at Fort Severn.

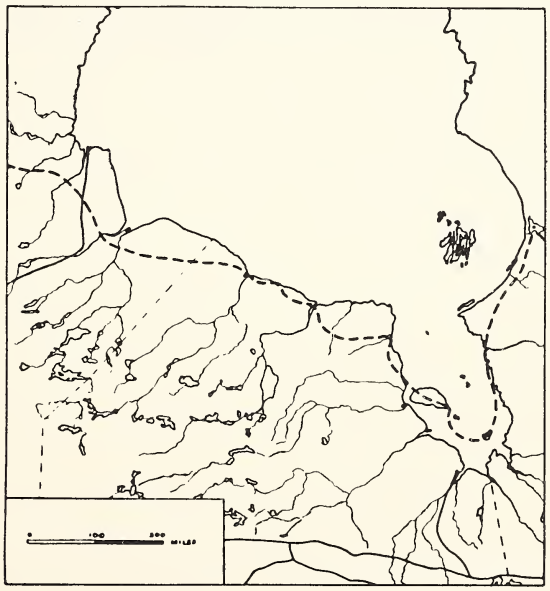
Attawapiskat River, 30 miles from the HBC-post; they mention that aspen is rare near the coast. It seems to grow well on the banks along the southern rivers inland. In the southernmost part of the region aspen sometimes forms secondary forests after fires and reaches a large size at least along the Moose River (H 1955). In the north aspen occurs (not commonly) as low deformed trees on sandy ridges, for instance near Fort Severn (see also Moir 1954), forming few vegetative shoots in the typical pattern of aspen on dry soil; no generative reproduction was noted at Fort Severn. Note the fact that the distribution of dioiceous tree species outside their »ordinary» distribution area mostly results in isolated outposts with vegetative reproduction as only means of survival[1]. The stems of aspen often have a striking white colour in the lowlands and, thus, from the air may look like white birch.

Balsam poplar (Populus balsamifera L.) is a common tree on low islands and slopes along the rivers. Fig. 4 shows the vegetative reproduction of balsam poplar on a low island 1 mile below Long Rapids in Mattagami River. The

[1]) This point recently discussed by Dr. M. J. Kotilainen (verbal.)

intensity of its vegetative reproduction explains partly why we often meet balsam poplar on low islands in the rivers and on slopes along the rivers, where the tree grows well because of occasional flooding. In some cases it seems that whole groves of balsam poplar (clones) probably developed from a single original seedling or vegetative shoot brought by the ice. It is an expanding species, but one has the impression that the balsam poplar not always succeeds in occupying its original area long before other species intrude. Balsam poplar easily develops rot. Balsam poplars over 80 years old appear scarce in the area, though this impression is based only on observations at Moose River and Fort Severn. At Moose River balsam poplars measuring 60—75 feet in height and 20 inches d.b.h. can be seen. Near Fort Severn the largest balsam poplars seen were about 30 feet in height and 8 inches d.b.h. Isolated balsam poplars on the river banks near Fort Severn showed good flowering in 1956, but in the dense but low balsam poplar groves on low islands or on low alluvial plains along the river, no flowering or generative reproduction could be seen.

As a typical pioneer species, the balsam poplar is of importance along the rivers over the whole area. Mixed white spruce, white birch, balsam fir and balsam poplar forests seem to be fairly common on the banks of the large



Map 5. A tentative map of the distribution of *balsam poplar*, a species which is rather common in the submerged area.

Fig. 4. Vegetative reproduction of balsam poplar in Mattagami Rivera a little below Long Rapids. A picture like this explains partly the rapid colonisation of "new-land", which is typical for the species. Photo: I. H. 1956.

rivers in the southernmost part of the region. Balsam poplar is left by the lumbermen when the forest is cut, see H 1955, and thus the species will become more common in the future in the southern part of the area.

White birch (Betula papyrifera Marsh.) is not particularly common in the area. In the southern parts of the region white birch occurs along the rivers, reaching a good size along the Moose and Abitibi rivers, where trees of up to 60—70 feet in height and 20—25 inches d.b.h. can still be seen. It occurs northwards to the Winisk River (54° 25′ n.lat.) according to Mc Innes (1908, 1912). No white birch was seen along the lowermost reaches of the Severn River. Low (1887) reports white birch from the Fawn River. In 1956, I believe I saw (from the air) white birch below the junction of the Fawn and Severn Rivers. The species seems to avoid the coast (except near Moose Factory and Albany post, cf. Potter 1934 and Dutilly et al. 1954); the same is the case on the east coast of James Bay. Betula papyrifera var. commutata seems according to Dutilly et al. 1954 to be the commonest white birch species[1]) in the area. Var. cordifolia is reported by Potter l.c. and H 1955 from the southern James Bay region.

On the whole, the broad-leaved trees compose only a minor part of the forest cover of the area.

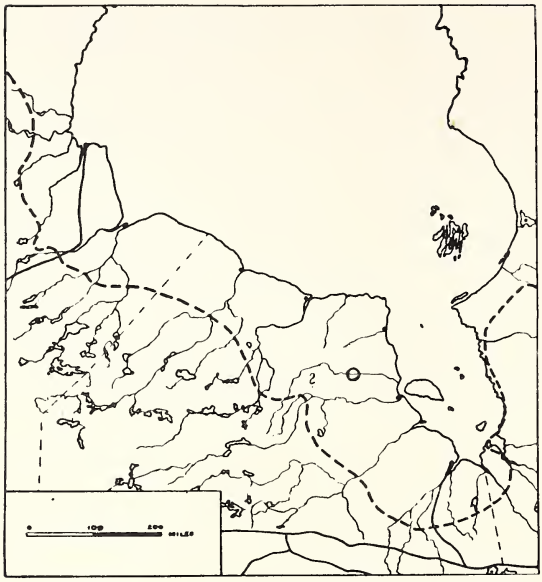
[1]) Mc Innes (1914, p. 57) collected a small birch species named Betula fontinalis Sarg. at the upper Winisk, outside our region proper. The same species (?), nowadays called Betula occidentalis Hook., was reported by Dutilly et al. 1954 from two points on the lower Attawapiskat and at Fort Albany (see map p. 73 in their paper) inside the region.

Map 6. A tentative map of the distribution of *white birch*, which in the northern part of the region clearly avoids the submerged area. The line in Manitoba according to a tentative map by Dr. J. C. Ritchie.

Red pine and *white pine* are not found in the region.

Jack pine (Pinus Banksiana Lamb.) is frequently reported just outside the Subarctic Hudson Bay Lowland proper, compare map in Native Trees of Canada 1950. Jack pine is common on the Precambrian shield and in the western provinces, where its distribution extends further northward than around the Bay. It seems that FERNALD's view (1919) that jack pine is restricted to Precambrian bedrock and sandy plains, eskers or moraines in such areas, is more or less correct. There are, however, some reports of jack pine from our region in the old explorers' notes, which are of great interest. O'SULLIVAN 1908 (1905) reports jack pine from Mesakonan, east of Hannah Bay. Opposite this point, on the east side of Nottaway Bay, POTTER (1934) reports jack pine on Mt. Sherrick, just east of our area.

But still more interesting is a jack pine locality mentioned by DOWLING (1914), five jack pines on the north shore about 50 miles inland from the mouth of the Ekwan River. On WILSON's map of 1903 we find the words, »One Banksian Pine» marked near Flint Rapid about 60 miles up the Ekwan River (this might be the same locality as seen by DOWLING, l.c.). On the same



Map 7 illustrates the distribution of *jack pine* in the region; Wilson's (1903) locality (also mentioned by Dowling 1914) marked with a circle.

map we have a note that the bedrock in question is Silurian limestone. The pines might, however, have been growing on a sand or gravel slope. As far as I know, this is the only locality for the species really inside our region. It is of interest to note that on Mc Innes's map of 1908 (1904) we have a »Pine Lake» in the upper Ekwan basin near Sutton Mill Lake.

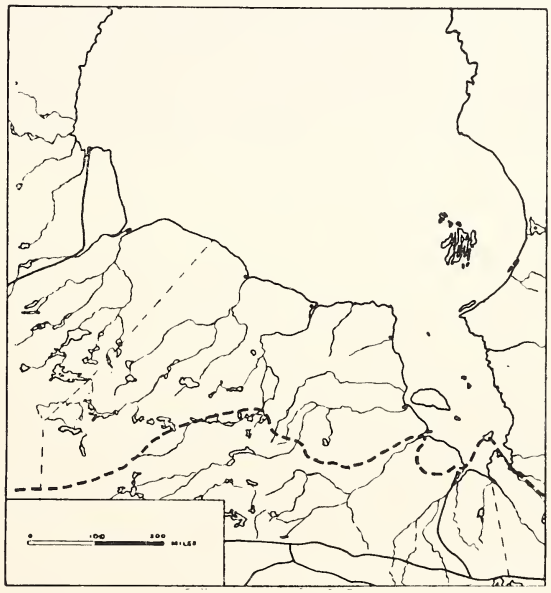
On our flight in 1956, we saw forests of what looked like jack pine between the Fawn and Severn Rivers. According to a letter from Dr. A. E. Porsild, this uncertain observation has, however, later been confirmed by Mr H. Lumsden. The locality is probably right on the western border of the Paleozoic bedrock area. — Scattered jack pines can be found (author's notes in 1952 and 1956) inside the southern border of our region near Coral Rapids and also near Long Rapids, Mattagami River (compare H 1955 re the extremely good growth of jack pine here).

The isolated localities are of great interest if we consider i.a. the need of very hot summers and forest fires for the dispersal of jack pine seeds. It is of course, possible that on the larger moraines inland between the rivers there are more jack pine forests. Cones may be brought down with the rivers and

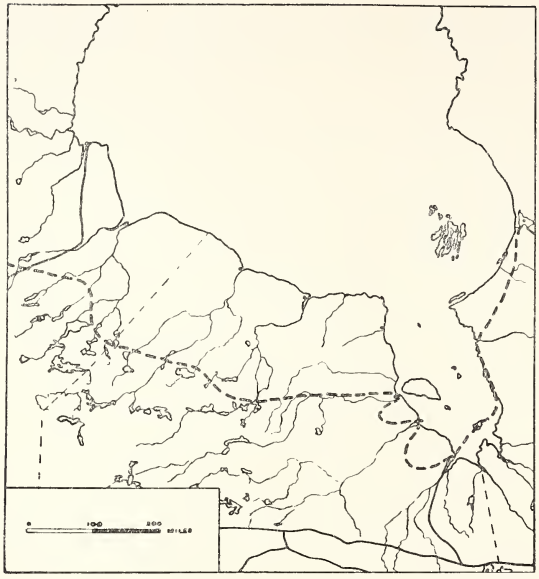
in a few cases the seeds may germinate on some warm river bank with a southern exposure. However, it is remarkable to note how jack pine more or less avoids the paleozoic area entirely. This feature is, of course, not restricted to Ontario. Dr. J. C. Ritchie, Winnipeg, has kindly sent me his tentative map of jack pine in Manitoba, which shows the same feature. The question certainly deserves closer study by foresters.

Cedar (Thuja occidentalis L.) is frequently found in the southern part of the region. Unlike the jack pine the cedar does not seem to show any marked preference for a particular kind of bedrock. Compare also the discussion in Fernald 1919, Raymond 1950 and H 1949.

Along the Moose River down to Moose Factory, we have rich cedar swamps with good reproduction but equally frequently vegetative propagation. A little below Long Rapids, in Mattagami, one finds cedar trees reaching 60 feet in height and 20 inches d.h.b., growing on undisturbed occasionally flooded soils. In constructing the map, use has also been made of information from the old explorers' maps. There is an interesting note by Dutilly et al. (l.c.) that the cedar grows somewhere along the lower Winisk River according to reliable sources. Compare, however, Bell (1887) who mentions that according



Map 8. A tentative map of the distribution of *cedar*.



Map 9. A tentative map of the distribution of *balsam fir,* which as cedar entirely avoids the northern part of the region. Compare its distribution on the east coast of Hudson Bay. The line in Manitoba according to a tentative map by Dr. J. C. Ritchie.

to an Indian cedar is unknown along Winisk River. Until further confirmation, the supposed cedar locality near Winisk is omitted from the map.

Cedar seems to grow well on sheltered river bay flats or on islands with occasional spring flooding and good drainage.

Balsam fir (Abies balsamea (L.) Mill.) has a distribution in this region similar to that of cedar. It is common on good habitats in the southern part of the area. Like the cedar, it reaches the coast along the Moose and Albany Rivers, although the balsam fir is commoner than the cedar. According to several sources, the balsam fir grows on upper Winisk, Attawapiskat and upper Severn Rivers. Good vegetative propagation is typical of this species, but at least along the lower Moose River and at Mattagami River the generative reproduction of the fir is more than sufficient in the old feather moss forests along the rivers and brooks (compare H 1955).

*

Fig. 5. "Spruce islands" somewhere between Moose River and Albany River. Photo: Dr. A. E. Porsild 1956.

Black spruce, white spruce and tamarack are common all over the area. They each have a distinctly different ecology generally, but in this extreme area one can also find all three species growing side by side in seemingly the same habitats.

Black spruce (Picea mariana (Mill.) BSP) occurs frequently on peat; the black spruce muskeg is a forest type common all over the taiga. Black spruce is also found on moraines and sand ridges, forming lichen woodlands. A peculiarity of the region seems to be black spruce lichen woodlands on peat (see below). In the northern part of the region, at Fort Severn, black spruce likewise shows good regeneration. In fact, I have never seen such dense cone formation on black spruce as here. The black spruce stops a few miles from the shore: my notes are insufficient to afford a clear picture of the reasons.

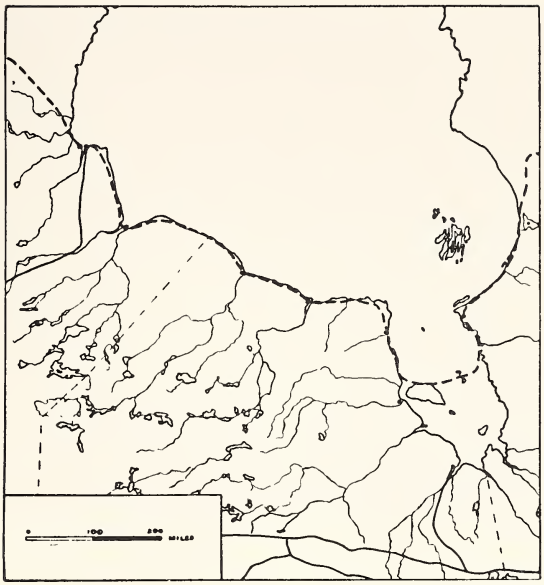
Likewise as on the east coast of Hudson Bay (H 1950) the black spruce does not reach the shore as frequently as the white spruce, which forms the maritime and polar tree-line here. Compare also PORSILD (1929) regarding the fact that white spruce seems to go further north than black spruce in western Canada. The oldest black spruce measured was about 200 years old. 40 feet in height and 8 inches d.b.h. seems to be the maximal size of the tree near Fort Severn, but in the southernmost part of the area we find well-grown black spruce reaching 60—65 feet.

The occurrence of spruce islands scattered on large tamarack fens is also a feature characteristic of this area. The dispersal of the seeds needed for the formation of these islands is in itself an interesting phenomenon. Snowstorms in the spring on ice-crusted bogs might be one means of dispersal. The rapid formation of »candelabra» spruce and the intense vegetative propagation in general by black spruce in this area also make it possible that many of the smallest »islands» in fact consists of one black spruce »tree» only. These »spruce islands», judging from the air, are very similar to the black spruce islands described by DRURY 1956 from the alluvial river plains in Alaska. Some of the small islands might be earlier »palsas» which have dried out and been covered by spruce. The larger black spruce islands (from the air they look like the atolls in the South Sea), have probably started from narrow black spruce borders around pools, which have slowly dried out, see Fig. 6. However, the problem must be studied on the ground.

White spruce (Picea glauca (Moench.) Voss.) has a wide range of habitats here. It occurs along the rivers on slopes and banks with good drainage, it grows in very wet Carex bogs and as low bushes on tundra-bogs and on the low sandy ridges that have recently emerged from the sea.

In the southern part of the region, along the Moose and Abitibi Rivers, the white spruce reaches a good size on the low islands in the rivers and on low, occasionally submerged banks. In such localities, the white spruce attains a height of about 100 feet and 40 inches in d.b.h. (compare e.g. H 1955, p. 27).

In the Fort Severn area, the white spruce reaches about 50 feet in height and 20 inches d.b.h. The growth of the annual shoots in many habitats in the northern part of the area is very small, only 2—4 cm even in white spruce. In such places a white spruce with many cones (1956 was a good cone year for this species all over the region) looks more or less like a black spruce from a distance. White spruce seedling were commonly seen near Fort Severn. The good growth of young white spruce in open willow or alder thickets was particularly noted. The small scattered white spruce bushes, 1—2 feet high on tundra bogs were on the other hand 50—60 years old. On the outermost



Map 10. The *polar limit of conifers* in the area, a combined tree-line for white spruce (usually outermost), tamarack and black spruce. The differences in their polar or "maritime" tree-line (see H 1949) is too small to be marked on a such map.

ridge at Fort Severn towards the sea scattered white spruce (no black spruce) and tamarack grow together.

In a few places, such as tundra bogs and swamps, the white spruce also showed a kind of vegetative propagation and formation of adventitious roots. »Candelabra white spruce» (compare H 1949 re the candelabra form of spruce) were noted, but not as well developed as those described from the east coast of Hudson Bay on the elevated sand deltas near Great Whale River (H 1950). No dense »carpet» or thicket formation of either white or black spruce was noted.

It is generally held that *tamarack* (Larix laricina (DuRoi) K. Koch) seldom forms pure stands in North America. However, on our reconnaissance trip we had to revise this opinion, for very large areas with pure tamarack could be seen, particularly in the southern part of the area W and N of the Moose River. These tamaracks were probably generally very small trees, only growing on hummocks or »ridges» with rather wet ground between the hummocks, tamarack fens or tamarack swamps; see p. 35 below.

Fig. 6. Black spruce ring marking pool, which has dried out? Somewhere between Attawapiskat and Cape Henrietta Maria. Photo: Dr. A. E. Porsild 1956.

Tamarack is generally a small tree in the area, which in some areas could be an effect of earlier attacks of larch saw-fly, see below. The tamarack reaches about 30 feet in height and 6—8 inches d.b.h. near Fort Severn and slightly more farther south. Cone production and the numbers of tamarack seedlings seemed to be good at least near Fort Severn. The formation of adventitious roots by the tamarack is a common feature.

Compared with my earlier tree-line maps from Ungava-Labrador (H 1949) we note i.a. that the distribution of balsam fir is more limited in the Subarctic Hudson Bay Lowland, whereas aspen and particularly balsam poplar are more common here.

NOTES ON THE VEGETATION

The succession of plant communities from the tidal flats to the dry land of the interior has not been studied to a greater extent in the area. Moir (1954b) will, however, probably soon publish his comprehensive work on the plant succession on the parallel sandy ridges (see above) along the coast, a succession which seems to follow the same general pattern as the much steeper

zonation of plant communities on the shores of the islands along the east coast of Hudson Bay (cf. H 1950).

The extensive marshes along the west coast are certainly of great interest both from a phytogeographical and from a more practical point of view. As far as I know, so far there are only floristic notes from these marshlands (compare DUTILLY, LEPAGE and DUMAN 1954). Great similarities in the succession of plant communities probably exist between the low and slowly emerging marshlands on the coast of the Gulf of Bothnia, and the marshlands of the Subarctic Hudson Bay Lowland. The notes by SOKOLOVA (1937) and KORCZAGIN (1937) from the low east and south coasts of the White Sea, show, as far as I can judge, pronounced similarities to the conditions in our area.

The *rivers* play an important role as creators of varying and changing habitats for the plant life. Fig. 8 a shows the vegetation pattern on the banks of the smaller rivers inland. Fig. 8 b illustrates the more complex pattern of plant communities on the shores of a big river in its lower reaches. The alluvial flats formed by the rivers and the low islands in the rivers, have a very

Fig. 7. Large open tamarack swamp, propably once a string-bog, which has been invaded by tamarack, the ridges still clearly seen. Photo: Dr. A. E. Porsild 1956 (N.33).

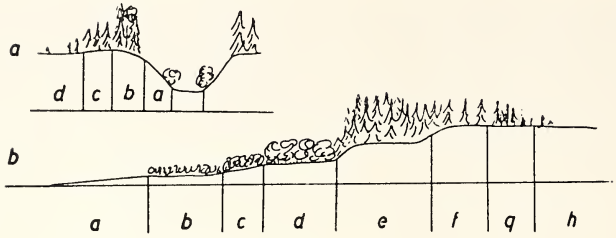


Fig. 8a. Profile of a small river inlands. a = slope with some alders, b = wellgrown white spruce forest (narrow belt with some poplars or birch) c = black spruce muskeg, d = open bog or open bog forest.
Fig. 8b indicates a profile of a larger river (mouth). a = fragmentary vegetation, if any (= "new land"), b = low willow field, c = denser and higher willows with some alders, d = balsam poplar grove, e = white spruce feather moss forest, f = black spure lichen woodland, g = black spruce muskeg and h = open bog or open bog forest.

labile vegetation cover. The pH of the soil of such habitats is generally high (see above p. 8). There is no struggle for space; the whole »vegetation» on such »new lands» (as, for instance, the steeper clayey slopes of the rivers) is rich in species, but it is also a rapidly changing flora composed of species of mixed origin and seemingly growing there without regard to any particular »natural laws». The large, more homogeneous and more important plant communities, e.g. bogs and forests, are here, as in other areas, formed by only a few species.

My Moose River paper (H 1955) illustrates to some extent the vegetation pattern of such a river habitat complex. In the southern part of the Subarctic Hudson Bay Lowland the vegetation was also astonishingly luxuriant. The general aspect of this scattered river vegetation in the north is, however, the same as in the south of the region, a vegetation of many species, mostly calcicoles and some rare plants, which are only found on such »new land».

On the lowest level we have an open vegetation cover of the kind described above, intermingled with pools with several aquatic plants and moist depressions with grasses and sedges. Slightly above this niveau, the pioneer bush willow forms open, not very dense »low-willow fields» about 2 feet high. In the openings around limestone boulders, on small sand or gravel ridges etc. we have a scattered fragmentary vegetation, which is slowly invaded by the expanding willow community. The willow species dominating this first stage are, according to my notes from Fort Severn, mainly Salix myrtillifolia[1]), S. calcicola, S. pellita v.psila and S. glauca coll. (det. Dr. A. E. Porsild).

[1]) Probably the commonest willow species in the area, growing in many different habitats and attaining different shapes, from a low creeping bush on the ridges to bushes 10 feet high in the balsam poplar groves.

Fig. 9. Low willow field, pioneer stage, on clayey river flat near Fort Severn. Photo: I. H. 1956.

On slightly higher terraces and slopes, probably moistened by springs through the clay, follows the next taller willow stage, consisting of denser thickest up to 5 feet high of such species as S. pellita v.psila and S. glauca coll. Alder (Alnus crispa) intrudes here more commonly than on the lower willow fields.

The following stage on ground that is a little higher and drier is the balsam poplar grove with low, balsam poplars often only 10—15 feet high (10 miles up the river 30 feet high), which form typical bright green patches near the rivers (easily visible from the air) and on the low islands. Under the balsam poplar we still find scattered and stunted willows, including Salix pellita v. psila and S. myrtillifolia. Regarding the willow species of the area, cf. RAUP (1943).

White spruce can be seen as an occasional scattered intruder in every stage described above. This tree seems to grow very well in these clayey and less acid habitats. On higher terraces that are occasionally flooded in spring, good white spruce feather moss forest is found.

The same general pattern of plant communities, from mixed »new-land» communities to spruce forest also occurs, more or less in its entirety, on the shores of Hudson Bay and James Bay (compare e.g. MANNING 1952). Reference may be made not only to the above-mentioned Russian authors from the White Sea region but also to a study of the forest succession on the skerries in Ostrobothnia (Finland) by APPELROTH 1948.

My notes on the *aquatic* vegetation of the waters are too fragmentary to permit any valid conclusions. As in the case of the marshlands, the aquatic vegetation should prove an important object of study in this region, so rich in ponds and lakes.

The whole pattern of vegetation in the region gives an immediate and impressive picture of a constant dynamic process, due to the changes of the river courses and the shore lines. But there are also other factors at work such as forest fires (see below) and intensive frost action. Compare i.a. Benninghoff 1952, Hopkins and Sigafoos 1951.

FOREST TYPES IN THE REGION

In H 1949, the forest types of the Labrador taiga were divided according to a simple formula:

Dry series: 1. Conifer lichen forest, 2. conifer dwarf shrub forest, 3. conifer blueberry forest.

Moist Series: 4. conifer feather moss forest, 5. conifer bunchberry forest, 6. rich conifer forest, 7. mixed groves.

Wet Series: 8. black spruce muskeg, 9. rich swamp forest, 10. open bog forest.

This tentative classification (compare Hare 1950 and Hare and Taylor 1956), can also be applied to the Subarctic Hudson Bay Lowland region. The frequency of the forest types is, of course, very different from the pattern in the Labrador-Ungava Peninsula, where dry terrain is more common and where the bedrock is different. Particularly types 1. and 2. or »lichen woodlands» (an expression used to combine the two types 1—2, compare Hare 1950) are very common there.

I believe my results from a survey of the Renison area along the lower Moose River (H 1955) give a general picture of the forest types in the southern part of the region. On the lower Moose River, dry forest types were very rarely seen, because there are no moraines or sand ridges in the area described in H 1955. The most frequent forest types are the black spruce muskeg, the open bog forest (with black spruce and tamarack), rich conifer forests (with white spruce, wellgrown black spruce and balsam fir with a ground vegetation rich in herbs), conifer feather moss forest, rich swamp forest (with tamarack and cedar) and mixed groves (a diverse complex incl. secondary

forests of white birch, aspen and balsam poplar, which are the result of fires and cuttings).

My notes from field-work in 1956 partly confirm the impressions of the earlier trips into the southernmost part of the region. At Sandbank Lake, in a region with thick peat soil, black spruce muskegs and old bog forests, of the same kind as everywhere in the taiga were seen (compare H 1949) and along Severn River the same forest types as described from Moose River occur, e.g. rich conifer forest, feather moss forests swamps and balsam poplar groves. But the studies in 1956 also added some observations of considerable interest: the existence of large *lichen woodlands*, still larger open *tamarack forests* and »rich» *white spruce swamps*.

The lichen woodlands occur on the many ridges which run parallell to the shore; they likewise occur on larger moraines in the interior, but also on peat.

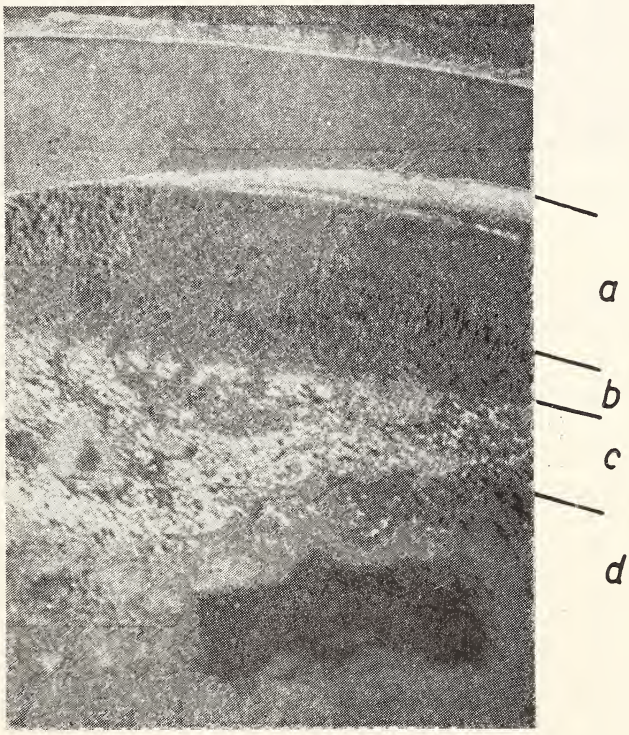


Fig. 10. Approximate pattern of successive formations along lower Severn River, about 30 miles (?) from the estuary. Photo: I. H. 1956. a = willows and probably incl. balsam poplar bush, b = white spruce forest, c = lichen woodland, d = muskeg and bog, incl. pool.

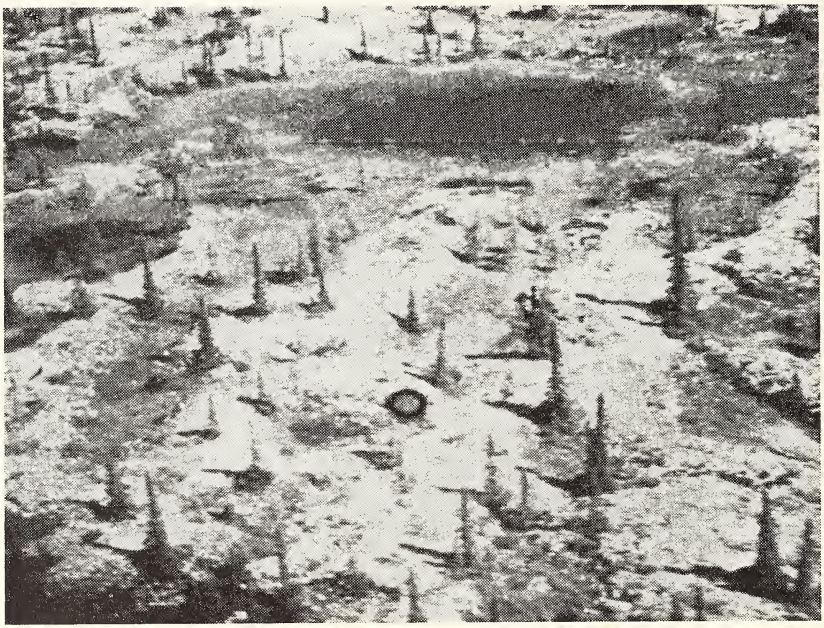


Fig. 11. Black spruce lichen woodland near Fawn River, probably on peat. Note pool filling in. Photo: Dr. A. E. Porsild 1956.

This third kind of lichen woodland has not hitherto been mentioned, as far as I know, from the Canadian taiga and is probably a forest type characteristic of the Subarctic Hudson Bay Lowland. In the southern part of the region it seemed that the lichen woodlands were entirely confined to moraines or former dunes (a statement which has still to be verified), whereas in the northern part of the region the lichen woodlands also occur on peat land. These observations mean that, contrary to earlier beliefs, we have in reality a wide, more or less unbroken belt of lichen woodlands from the Labrador Atlantic coast (compare H 1951, HARE and TAYLOR 1956) to Athabaska (RAUP 1947) and Alaska.

There must be a climatic reason for this belt of lichen woodlands, but so far we have no real key to the problem (compare also SARVAS 1952). There seems for instance, to be no correlation at all with the moisture index worked out by SANDERSSON for Canada (1950); our lichen belt cuts through all the climatic regions from dry to humid climates.

Cladina alpestris, C. mitis and C. rangiferina are the three commonest lichen species, particularly the first, which covers the floor of these open

spruce forests. Except on well-drained ridges with fine sand where white spruce grows, black spruce is the dominant tree in the licher woodlands, usually growing as so-called candelabrum spruce (H 1949 and 1951). Under the spruces one finds a few mosses and dwarf shrubs, but the lichen is dominant.

It seems that lichen woodlands develop slowly also on old peatland and on bogs deformed by permafrost. Lichens growing on hummocks and ridges in the bogs are a familiar sight. In old peat bogs, Cladinae grow in hollows and depressions (noted e.g. on an open bog forest at Sandbank lake). This shows the wide ecological amplitude of the lichens and their independence of the substrate. The lichen growth (particularly Cladinae) on peat formations is in the author's opinion a Subarctic feature and is particularly marked in the region dealt with here. The fact, that the lichens are more or less independent of the substrate on which they grow (cf. Buch 1947) is one reason why one would except a high correlation between some climatic factor and the distribution of lichendominated vegetation.

From many points of view, ecologically and forest-geographically, the lichen woodlands of the Subarctic Hudson Bay Lowland are of great interest and well worth further study in the future. They also indicate the drier terrain in the fascinating pattern of vegetation types seen from the air in the region, starting with the ridges with scattered spruces on lichen near the coast and ending far inland; wherever we have sand or gravel or dry old peatland we seem to have lichen woodlands.

It should be noted that this type of forest, lichen woodlands, is of no importance in forestry. This is mainly due to the extremely slow growth of the low trees (often of candelabrum form with many stems close to each other); also the cubic volume per acre is the lowest possible in this very common Subarctic forest type (H 1951).

The second surprise regarding the forest types in the region was the widespread occurrence of open swampy tamarack forests which could be seen west and north of the Moose River. It seems that these pure tamarack forests generally consists of low tamarack, hardly more than 10 feet high (a statement which needs confirmation).

An interesting feature, in most places clearly visible from the air but not so easily seen from the ground, was that the tamaracks grow in a »string» pattern, as if the terrain had once been ploughed up and the tamarack planted between the furrows. This string pattern is almost certainly due to the fact that some of these large flat tamarack stands have developed on former string bogs. Tamarack could in some places actually be seen »invading» treeless string bogs.

Fig. 12. On our flight we saw several forest fires in the area northwest of Winisk River. Here a lichen woodland in fire. Photo: Dr. A. E. Porsild 1956, from an area near the Manitoba border.

The existence of these large open tamarack forests on swamps between the rivers partly explains how the tamarack saw fly is able to invade so large areas so rapidly. Late in the summer of 1956 a mass attack of tamarack sawfly was observed near Coral Rapids at the southern border of the area. Regarding the damaging effect of the previous attacks by this insect, resulting in dead tamarack trees over wide areas, compare, e.g. Mc Innes 1908 (1905) and Munroe 1956. In areas, where the topography or the climate forms no natural barriers *insect attacks* on such sensitive species as tamarack and broadleaved trees must have considerable influence on the evolution of forest types.

The white spruce swamps observed near Fort Severn (they are probably very common near the coast all over the region), are another interesting forest type. Here white spruce could be seen growing on wet ground vegetation of Carex aquatilis,[1] C. saxatilis v. rhomalea, Petasites sagittatus, Scirpus caespitosus ssp. austriacus, Drepanocladus revolvens, Campylium stellatum,

[1]) Vascular plants det. by Dr. A. E. Porsild; mosses by Dr. R. Tuomikoski; see also below p. 38—41.

etc. Similar white spruce swamps were noted at Sucker Creek near Great Whale River (H 1950). The white spruce forests with a ground vegetation rich in herbs or seemingly of feather moss (Hylocomium splendens) type were also unusually wet in their appearance.

One fact having an immense influence on forest type development in the region remains to be pointed out; the *forest fires*. The reports of the first explorers of the area give the impression of the devastating effect of forest fires in this area where forests are sparse (compare for instance, the reports in »District of Patricia» 1912). Mc Innes (1912) writes of the Winisk area that »evidence of the constant recurrence of forest fires over the area is everywhere plainly seen». In this respect, the lichen woodlands are plainly the most susceptible. A further noteworthy point is the importance of unchecked forest fires as a factor in increasing the paludification of the forests in this humid climate. The evaporation on a burned area decreases. This causes rise of the water table, which again results in an increased swampiness of the terrain. In an area where the common feather moss species (Hylocomium, Pleurozium and Ptilium) occur together with Sphagnum species as mixed moss floor vegetation, fires kill the feather mosses more easily than the Sphagnum moss cover, which is then left to expand its area in surroundings wetter than before. It thus seems that large forest fires are an active factor in keeping the area

Fig. 13. Forest fire in 1955 near Coral Rapids, photographed in August 1956. The white patches are Sphagnum moss, whereas the Hylocomium feather moss was entirely killed, as also the trees. Photo I. H.

swampy and boggy, thus retarding the improvement in drainage due to the gradual crustal uplift of the land.

Forest fires and insect attacks must be considered as much more important elements in the evolution of the forests in the Subarctic than has previously been realized. These »uncontrollable» factors have in earlier decades moulded the forest types regardless of all the theoretical succession stages we have deduced for the forests.

ON THE BOG TYPES IN THE REGION

Black spruce muskeg, lichen woodland on peatland and open tamarack forests have been included above among the forest types. They could as well be described in connection with the bog types. Regarding the open tamarack forests, it seems almost certain that their origin is the above described evolution from a string bog to an open tamarack forest. Regarding the black spruce muskeg I am not certain. In this case, the slow paludification of the forest might be a factor of importance as well as the development of open bog forests into well-wooded muskeg.

The area affords good opportunities to study almost every type of bog and fen. Bordering the marshlands and the first shore beaches we find open wet Carex aquatilis and Equisetum limosum formations (incl. Scorpidium scorpioides, Calliergon giganteum etc.). When more peat is formed, the vegetation changes into ordinary fens and bogs.

The peat bogs are of the same type here as in the surrounding parts of the Canadian Shield. A note of the plant cover from Sandbank Lake from an open bog on thick peat: Chamaedaphne calyculata dominant, Ledum groenlandicum (common), Kalmia angustifolia (common), Eriophorum opacum (common) and scattered Sarracenia purpurea, Rubus chamaemorus, Oxycoccus microcarpus and Smilacina trifolia on Sphagnum parvifolium and S. magellanicum, a note which could have been made in any part of the Labrador taiga (compare H 1950). On these bogs low hummocks or ridges covered with dwarf shrubs alternate with Carices and Eriophora between the hummocks.

In the northern part of the region, in places with enough peat and intensive frost action, low »palsas[1]», i.e. larger hummocks, are formed. Some of these probably (the statement has to be confirmed) develop later into the »spruce islands» described above. However, much more study is needed in this field.

[1]) Compare i. a. Porsild 1938, H 1939, Wenner 1947, Moss 1953 a. o.

Where the water table is closer to the surface or the drainage is better, the influence of the Palœozoic bedrock and the clayey sediments clearly reaches the vegetation. In such places we have *fens* (compare Sjörs 1948), rich in herbs and with Carex communities alternating with socalled brown mosses (Drepanocladus, Calliergon, Paludella, Aulacomnium, Tomenthypnum, etc.); here we also find several calcicole species.

For communities with a similar, more or less calcicolous vegetation but with trees (in this area white spruce or tamarack) the expression *swamp* could be used. This leaves us the tentative concepts bog, bog forest (open) and muskeg as names for plant communities on more acid habitats, where the moss cover on the peat is entirely dominated by different Sphagnum species. All these communities seem easier to distinguish in nature than to classify in writing. Compare, however, Cajander 1913, Dansereau and Segada-Vienna 1952.

Regression and depletion of the bog surface due to »intensive frost action» (as defined by Hopkins and Sigafoos 1951) is one of the factors mainly responsible for the physiography of the terrain. Another factor in the physiography is the alternate drying up and paludification which seems to continue rather irregularely and mainly depending on the changes in the river courses and drainage pattern from place to place. In such a flat area where only peat hummocks or low shore ridges (except for the Precambrian Sutton Lake area) rise above a surface marked with stagnant water, even small changes in the water table have marked effects on the micro-topography of the bogs.

String bogs of several types, with parallel low ridges or with ridges in large net formations are general in the region. String bogs with water plainly visible between the ridges are as common as string bogs with Carices, Eriophora, etc. between the ridges. String bogs which seem to have dried up and been slowly invaded by tamarack could be distinguished from the air in some places.

Of course, string bogs are not restricted to this region, but as far as I can judge from the literature and from my own observations from eastern Canada and Labrador, the string bogs in this region are more clearly developed than in other parts of eastern Canada. String bogs are mentioned or described by a number of writers, e.g., Tanner 1944, Wenner 1947, Moss 1953, Hare and Taylor 1956, Drury 1956, and, of course, by a number of European authors.

These string bogs seem to be very similar to those in Northern Europe and Siberia. Like the boreal forest types, also the bog types are in general circumpolar in their distribution. String bogs were not observed very near the coast (this statement needs verification).

Fig. 14. Typical string-bog, without trees, with low parallell ridges against the direction of the slope. The water filled areas between the ridges about 5—10 meter wide mostly. This picture is from the southwestern part of the region near Albany River. Photo: A. E. Porsild 1956.

The ridges or hummocks on the string bogs (studied by AUER 1920, SJÖRS 1948 and DRURY 1956 among others) are formed by drier peat covered with dwarf bushes with mosses and lichens, and are orientated across the direction of the slope. But, contrary to the first impression one gets from the air, the slope of the string bogs may be almost nonexistent and still cause these remarkably clear patterns (Fig. 14). According to AUER (1920, p. 78) the slope of some string bogs in northern Finland is only 0.3 to 0.4 meters per km.

Raised bogs (Hochmoor» formations), i.e., bogs which in the centre are higher than in the periphery, were at least seen just south of the border of the region. Regarding the concept see i.a. DRURY 1956. The more pronounced growth of peat in the centre of these bogs causes different and »drier» vegetation. My observations were, however, too sporadic and not backed by sufficient previous experience of this type of bog to allow any conclusions.

One particular kind of »raised bog» can be seen in the northernmost part of the region, »tundra bogs». They are small, rather dry »bogs», or heaths, which are slightly raised in the centre and with a vegetation of more or less arctic

and calcicolous mosses and vascular plants (Dryas integrifolia, Pedicularis flammea, P. sudetica, P. lapponica, Carex scirpoidea, Anemone parviflora, Tofjeldia pusilla, Arnica attenuata, Saxifraga aizoides, etc.); typical peat deformation caused by intensive frost action also marks these »tundra bogs» near Fort Severn. I cannot judge how common they are, but they probably occur all along the coast from Cape Henrietta Maria northwards in narrow belts. They probably represent a climatically (?) restricted type of bog, which has slowly developed into arctic heaths.

Most of the problems connected with bogs and fens, forests and muskegs have been earlier studied in Northern Europe and in Russia. However, I think it will still be necessary to start entirely from the »ground» in this particular region, which probably has no definite counterpart in any other part of the Subarctic, compare below.

Is there a »paludification» or a »drying» going on in the area at present? It seems that both processes are going on beside each other, depending on the microtopographical conditions on each habitat. The evolution of the bogs is still more dynamic than the evolution of the forest types, because the growth of the more or less exposed peat must be considered as a factor more dynamic than the slow development of the soil of the forests.

In his paper on the Hudson Bay Lowland south of 60° degrees north, Coombs (1954) divides his region into physiographic subdivisions: a) Dry Zone, b) Muskeg and Small Lake Zone, c) Marine Clay Zone and d) Coastal Zone. The Dry Zone is marked by approximately 40 % dry land, which is not very much for a »dry zone», but Coombs uses this expression only in a relative sense, to stress the difference between this southern, rather well wooded subdivision in contrast to the still more watery northern regions. According to our observations, this southern area also shows both great open tamarack, and large string bogs. It seems that physiographically it would be logical to let the southwesternmost part of the region form a subdivision of its own, compare Hills 1952.

The interesting Muskeg and Small Lake Zone is physiographically adequately described by Coombs himself and by Hanson (1950). To what extent all the »smallpox» formations (sensu Hanson) are due to the »pockmarked effect» of the sedimentary filling of former lakes and ponds, is difficult to judge. In some places — such was my subjective impression during our flight — the phenomenon was the result of former, low but large dune terrain having been filled by small bogs or pools as a result of insufficient dissipitation of

Fig. 15. The moulding of a landscape. "Patterned scum marshes west of Moose River estuary. Near coast series of raised beaches covered by spruce. In the marsh islands of black spruce. In background tidal flats and foot of James Bay with pack ice showing on horizon." Photo and description by Dr. A. E. Porsild 1956.

excess moisture, particularly in the northern part of the area. This hypothesis, of course, needs verification from studies on the ground.

North of the Severn River, according to COOMB (l.c.), his »Marine Clay Zone» begins. Our reconnaissance flight covered only a very small part of this area with its »immature appearance» due in part to recent uplift and to intensive frost action. One also finds such »marine clay» terrain a little south of the Severn River.

The Coastal Zone and its characteristics have already been briefly discussed above and COOMBS' description 1952 and 1954 (compare also MANNING 1952 and MOIR 1954) gives the essentials.

ACTIVITY OF MAN

This large area of about 150,000 sq. miles has a very sparse population, probably of not more than 2,000 people, mostly Indians. I refer to COOMBS comprehensive thesis (1952) for more details regarding the population of the region.

Only in the southern part has there been any *activity in the forests*. Lumbering has been restricted, so far, to the Moose and Abitibi rivers. The cuttings started with the building of the Temiskaming and Northern Ontario Railway from Cochrane to Moosonee (1922—31). Cutting was stopped in 1931 because of the general depression in the forest industries. It was resumed, however, in 1933 and has increased since then. There has also been some small-scale activity around Fort Churchill and along the »Hudson Bay Railway» to Fort Churchill inside this region.

Important timber resources are found only in the southern part of the region. Here along Moose, Mattagami, Abitibi and lower Albany River etc. we find wooded areas, which can be accessible when needed.

Lumbering increases the proportion of balsam poplar, aspen, white birch and balsam fir in the forests and, thus, changes the character of the vegetation. To what extent the cutting adds to the paludification is one of the questions which is of special interest in this region.

In other parts of the region the activity of man until recently has been restricted to the Hudson Bay Co and other stations at the mouth of the rivers (Moose Factory, Fort Albany, Attawapiskat, Winisk, etc.) and to winter trapping by the Indians. Thus, the Subarctic Hudson Bay Lowland is phytogeographically almost entirely a true virgin area. Only at the above mentioned stations can one discern any effect of mans activity on the flora and vegetation. Cuttings have been made for fuel and building timber in the forests nearest to the stations, causing on a smaller scale the same effect as cuttings everywhere, i.e. »secondary forests».

Around the larger settlements (particularly Moose Factory, Moosonee and Fort Albany) a number of introduced or adventive plants can be found near fields and gardens, compare the plant list of DUTILLY et al. 1954. One must also consider the effect of cuttings, small roads, paths, ditches, etc. in changing the vegetation by creating »new land», where some of the native vascular plants grow extremely well, whereas others native species slowly disappear. We are here in the beginning of a process which in more populated parts of the Subarctic (as northernmost Europe, for instance) has caused marked

changes in the native flora. Also for the study of this problem, e.g. the *inception of »apophytism«*[1]), the Subarctic Hudson Bay Lowland, with its scarce populations centred in a few stations, is amply suited.

COMPARISONS WITH SIMILAR AREAS IN OTHER PARTS OF THE SUBARCTIC

There are not many such areas as the Subarctic Hudson Bay Lowland in the world. Because of its inaccessibility until recent years the region is one of the least known phytogeographical regions in Canada.

To a certain extent (crustal uplift after submergence in postglacial time and low flat peat dominated terrain) the same geographical conditions prevail at the coast of the Gulf of Bothnia between Finland and Sweden. The main difference is that in the Bothnian region there are no sedimentary bedrock under the clay and peat. We have many papers by Swedish and Finnish authors concerning the vegetation and quaternary geology of the Bothnian region, compare Leiviskä 1909 and Mölder and Salmi 1954.

The White Sea extends into the Russian taiga from the north and is in this respect comparable to the Hudson Bay. The shores of the White Sea are partly low and flat. On the east and south shore are large marshlands on the sea-alluvium near the Mesen Bay, compare Korczagin's descriptions (1937); this paper should be read by future explorers of the marshlands of the west coast of Hudson Bay. Sokolova (1937) describes larch, pine and spruce forests from the Onega-Dwinskij area, growing in part on sedimentary bedrock and in areas which have been partly submerged during postglacial time; the phytogeographical similarities are marked. The Kuloi region near the White Sea belongs to the forest-tundra; 90 % of the area is covered with Sphagnum bogs, i.a. string bogs and palsa bogs, compare Leontjev 1937.

Large parts of the Siberian Subarctic cannot be compared with the Subarctic Hudson Bay region because of different quaternary history. However, on the large alluvial lowlands between Petshora and Taimyr probably partly similar vegetation conditions prevail as in our area.

The northern coast of Alaska and the alluvial plains in forested central part of Alaska, compare Drury (1956), show similarities to the Subarctic Hudson Bay Lowland.

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[1]) Apophyte is a plant which although native in an area is favoured and expanding by the activity of man.

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ACTA GEOGRAPHICA 16, N:o 2

THE HUMAN GEOGRAPHY OF THE OUTER HEBRIDES

WITH SPECIAL REFERENCE TO THE LATEST TRENDS IN LAND-USE

BY

STIG JAATINEN

HELSINKI—HELSINGFORSIAE 1957

HELSINGFORS 1958
PRINTED BY A.-B. TILGMANN

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PREFACE

During fifteen years of study, covering both the physical and the human aspects of the Åland Islands, the most extensive archipelago in the Baltic Sea, I have become deeply interested in the geography of islands. Since my youth, the North Scottish Archipelagoes, a British counterpart of this most maritime and insular area of Finland, has had a great attraction for me, and this attraction eventually deepened into a keen interest. In the spring and early summer of 1956, after a year at University College, London, I was happy to have the chance to travel through all the major islands of the Outer Hebrides. The unique character, the extreme remoteness, the singular way of life of the Hebrideans and their acute problems responded in many ways to my anticipations.

The impressions arising from this journey, covering the economic geography of the islands, with special reference to population distribution and agricultural land-use, have now been crystallized in this paper. Its main aim is to make a contribution to the neglected field of »Island Geography». The thesis will include a survey of the physical background, some considerations of the historical development and a review of the literature of the human geography of the Outer Hebrides. The literature covering both the human and the physical geography of these islands is very extensive and a comprehensive review is well worth while. For many years, the setting, the character and the historical evolution of the Outer Hebrides have inspired numerous authors. Among the earlier sources are the descriptions of DEAN MUNROE (1549), MARTIN MARTIN (1695), STATISTICAL ACCOUNT (1790), J. ANDERSON (1785), J. BUCHANAN (1793), J. MACDONALD (1811), J. MACCULLOCH (1819, 1824) and the NEW STATISTICAL ACCOUNT (c. 1840). Both these and the numerous more recent treatises have confined themselves to general surveys and investigations, very seldom giving detailed examples. Land-use maps of different crofts will be included in this paper, for they will be of increasing interest, since the structure of the islands' economy, including the agricultural land-use, is at present undergoing quite a rapid change. In fact, a comprehensive survey of the fading pattern of the old crofting communities and their economy and a picture of the transition towards a new balance is urgently needed. The frame is provided

by the exellent »WEST HIGHLAND SURVEY», but much detailed work still remains to be done.

In order to stress some features common to the geography of the two archipelagoes, comparisons will be drawn between conditions in the Outer Hebrides and in the Åland Archipelago.

The success of my Hebridean journey was largely due to the hospitality and helpfulness of my crofter hosts, who through their appealing attitude towards a stranger, and their traditional way of life, still in many respects undisturbed by the disharmony of modern times, left with me the deepest impression. I wish to thank especially the family of Kenneth Campbell, Bragar, Lewis, with whom I spent my first week in the Outer Hebrides and who contributed profoundly to my understanding of the crofter's life.

I also owe most sincere thanks to Prof. Ronald Miller of Glasgow and his assistant, Dr James Caird, who helped me untiringly with the arrangements for my tour and with whom I have afterwards had the valuable opportunity of discussing many topics. Dr Caird has also kindly read the paper in its final stage. Further more I wish to thank my friend, Dr. W. R. Mead of University College, London, who has made several suggestions about the manuscript. Thanks are also due to Ross and Cromarty County Council and especially to Mr C. J. Harley, author of the Survey Reports on different parts of Lewis. Mr Harley has contributed with several valuable points for the chapters III and IV.

Finally, I will acknowledge with gratitude that the journey was assisted by a grant from the Swedish School of Economics, Helsingfors.

The maps, diagrams and figures are drawn by Mrs Meri Streng and Mrs Elvi Svento, I take this opportunity of expressing my appreciation of their work. The English has been checked by Miss Ann Crossett. The airphotographs are reproduced by courtesy of the Royal Air Force.

I. THE PATTERN OF THE ISLANDS

1. SETTING AND COMMUNICATIONS

a. Situation and Extent

The geographical position of the Outer Hebrides is of great interest for two reasons. Firstly, because they form one of the most northerly parts of Great Britain, secondly, because this extended group of islands is like an arcuate barrier or breakwater beyond the west coast of Scotland, which is in itself in-

hospitable and isolated.[1]) The individuality of the Outer Hebrides and the adjacent parts of the Scottish Highlands is characterized by COLLIER as follows:

»The Highlands and Islands are in a number of respects significantly different from any other part of the British Isles. Their nearest counterparts are to be found in certain districts in Ireland, though even here there are important elements of difference. The configuration of the country; its remoteness from the great urban concentrations of population and the sparseness of population within the area; the importance of island life, an isolated phenomenon in other parts of Britain, but normal and indeed characteristic of the Highlands; the insidious climate of the north and west; the scarcity of cultivable soil; the poverty of natural resources, particularly coal and iron, and the consequent absence of industrialization: these mark out the area as very different from other regions of Britain.» (A. COLLIER 1953, p. 4).

The exact geographical position of the Outer Hebrides, also called »The Long Island», is between 56° 48,5′ N. (Barra Head) and 58° 31,3′ N. (Butt of Lewis), and between 6° 8,5′ W. (Tiumpan Head on the Eye Peninsula of Lewis) and 7°40′ W. (the west coast of Mingulay). The islands are situated as far north, for instance, as Småland in Sweden.

The maximum length of the Outer Hebrides is about 218 kilometres and their greatest breadth (in south Lewis) is 48,5 km. There are about ten islands of some size in the Outer Hebrides. Among the most important of these are Lewis-Harris, North Uist, Benbecula, South Uist and Barra. In the straits known as the North Minch are the small Shiant Islands, which are also a part of the Outer Hebrides. East of the Minch, along the west coast of Scotland, there is another group of islands, the Inner Hebrides, which again consists of about ten bigger islands, Skye, Mull, Jura and Islay, and the smaller Raasay, Canna, Rhum, Eigg, Staffa, Iona, Colonsay, Lismore and Gigha. See Fig. 1.

The total land area of the Outer Hebrides is 177.226 ha. (WEST HIGHLAND SURVEY). According to other informations (quoted by MACGREGOR 1949) the total is 177.150 ha., of which 100.045 ha. is in Lewis, 30.631 ha. in Harris, 18.672 ha. in North Uist, 22.300 ha. in Benbecula and South Uist and 5.500 ha. in Barra. To this total can be added the fresh waters, altogether occupying 11.414 ha., the salt-marshes — 77 ha., the foreshore — 11.289 ha. and the tidal waters — 374 ha. (see Table 1).

[1]) GEDDES (A. GEDDES 1955, p. 3—6) looks at the British Isles in a new way, from the north-west. Thus the Outer Hebrides become »A 'Heart' of the 'North and West' of Britain» representing the oldest core, concentrically surrounded by successsive regions of geologically younger age.

Beginning in the south the islands of the Outer Hebrides can be grouped as follows:

1. Barra Isles: *Berneray* (the inhabited islands will be in italics) Mingulay, Pabbay, Lingay, Flodday, Sandray, Muldoanich, *Vatersay*, *Barra*, Fuiay, Flodday, Hellisay, Gighay, Fuday and Fiaray.

2. Uists: *Eriskay*, Lingay, *South Uist*, *Benbecula*, Wiay, Ronay, *Grimsay*, *North Uist*, *Baleshare* (actually only a foreshore bar), Kirikbost Island, (another foreshore bar), *Boreray*, *Berneray*, Lingay, Pabbay and a great number of small uninhabited islands NE of North Uist (27 in all). Farther out in the west there are also the Heisker or Monach Islands, Haskeir Islands, St Kilda Islands (Dùn, St Kilda and Soay) and Boreray.

3. Lewis-Harris: Killegray, Ensay, a great number of small islands (about 20), forming an almost unbroken connection with the islands on the north side of North Uist, *Harris* (connected with *Lewis* at Tarbert), *Taransay*, Soay Beg, Soay More and Isay on the western side and *Scalpay*, Scotasay, including an archipelago of small islands on the eastern side of Harris. West of southern Lewis (or actually the northern part of Harris) is *Scarp*, and farther to the north (belonging to Lewis) Mealasta Island, *Great Bernera* including an archipelago of small islands in West and East Loch Roag, Little Bernera, Flannan Isles (in NW), and farthest to the north Sula Sgeir and North Rona. East of Lewis—Harris are the Shiant Islands which have already been mentioned and still closer to the east coast of Lewis there are a number of uninhabited islands, most of them in the neighbourhood of the mouth of Loch Erisort. There are too, the Loch Seaforth Islands in the fiord of the same name and Eilean Iuvard in Loch Shell. North of the Eye Peninsula, which is actually an island connected with Lewis by a sandbar, there are no islands.

The Outer Hebrides thus consist of about 15 inhabited islands. West Highland Survey mentions 18 and Hance (1949, p. 32) 29 inhabited islands, neither source however has any detailed list. In many cases it might be a question of islands which are only temporarily inhabited during the summer. On the other hand, a number of islands have been deserted during the past few years.

Table 1 shows the proportion of land and water in the different islands and island groups. A closer examination of the proportion of land and water in the islands will be made when the relief is discussed. Here it is enough to stress the difference between Lewis—Harris, which has a land area of about 92 % of the whole, and the rest of the islands. Dry land occupies only 72 % of the whole of North Uist, which is a result of extensive lake waters (8,5 %) and periodically submerged coastal areas (17,9 %).

Table 1. Distribution of land and waters[1]).

Islands	Land area km² / %		Inland waters km² / %		Salt-marshes km² / %		Foreshore km² / %		Tidal waters km² / %		Total km²
Barra Isles .	55,0	86,4	2,44	3,6	—	—	6,42	10,0	—	—	63,83
South Uist & Benbecula .	223,0	81,8	22,67	8,3	—	—	26,18	8,7	0,85	0,3	373,79
North Uist .	186,7	72,9	21,89	8,5	0,2	0,07	45,66	17,9	2,25	0,8	256,70
Harris	306,3	92,9	7,69	0,2	—	—	15,38	4,6	0,26	0,08	329,63
Lewis	1.000,5	92,4	61,54	5,6	0,57	0,04	19,25	1,8	0,37	0,00	1.082,23
Totals for the Outer Hebrides...	1.771,5	88,6	114,14	5,6	0,77	0,04	112,89	5,6	3,74	0,2	2,003,04

b. External and Internal Communications

The isolation of the Hebrides from other parts of Scotland, and especially from the Scottish Lowlands is striking. The railway journey from Glasgow to Mallaig, one of the three important harbours on the mainland which serve the Outer Hebrides, takes six hours. It takes the same time to travel from Edinburgh via Inverness to Kyle of Lochalsh, one of the other centres for communications with the Hebrides. The last mentioned railway route does not have to overcome so many topographical obstacles as the Glasgow—Mallaig line, which at two points has to cross over passes which are over 1.000 feet in height, and which descends to sea-level between them. The third port on the west coast of Scotland with connections to the Outer Hebrides is Oban. It takes about three hours by train from here to Glasgow, but the distance in time from Oban to the Outer Hebrides, and then only reaching to Barra or South Uist, is thirteen hours, in contrast to a time-distance of six hours from Mallaig to South Uist or Stornoway and four hours from Kyle of Lochalsh to Stornoway. Daily air connections are nowadays maintained between Glasgow and Stornoway, and from here there is an extension to South Uist.

There are three sea routes which serve different parts of the Hebrides. First, the most important, the Mallaig—Kyle—Stornoway route with connections in both directions on every weekday. Secondly, the Mallaig — Lochboisdale (South Uist) — Lochmaddy (North Uist) — Tarbert (Harris) — Kyle — Mallaig route, which runs three times a week in either direction. Thirdly, there is the Oban — (— Coll — Tiree —) Castlebay (Barra) — Lochboisdale route which also runs thrice weekly.

[1]) Compiled from MacGregor 1949.

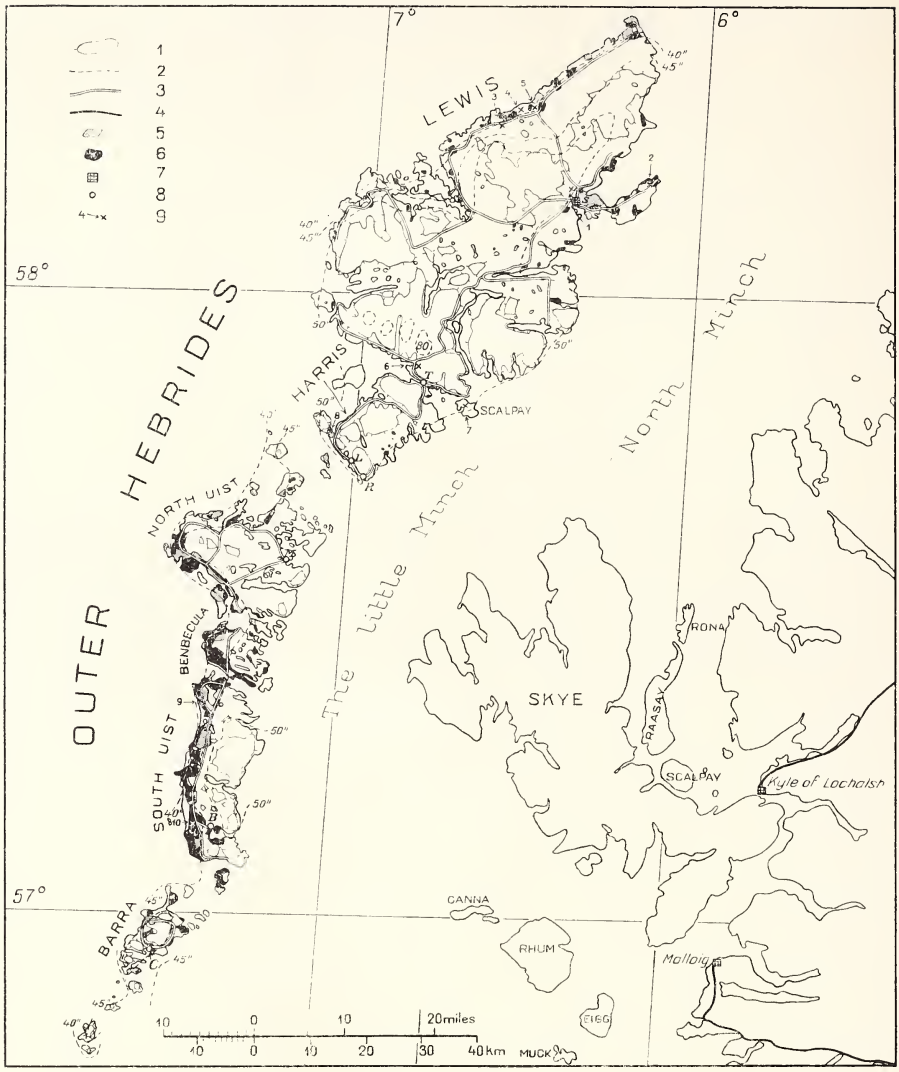

Fig. 1. The Outer Hebrides, situation and pattern, compiled from the Ordnance Survey maps of Great Britain in the scale 1: 625.000. 1 = 100 feet contours, 2 = Isohyetes (inches) of annual average rainfall (1881—1915), 3 = Roads, 4 = Railroads, 5 = Meadowland and permanent grass, 6 = Arable land including fallow, rotation grass and gardens, 7 = Towns, 8 = Places mentioned in the text, S = Stornoway, T = Tarbert, L = Leverburgh, R = Rodel, M = Lochmaddy, B = Lochboisdale, C = Castlebay, 9 = Townships shown on land-use maps and airphotographs (1 = New Valley, 2 = Portvoller, 3 = Bragar, 4 = Arnol, 5 = Barvas, 6 = Ardhasig, 7 = Scalpay, 8 = Northton, 9 = Iochdar, 10 = Daliburgh).

The differentiation of these lines of communication gives a hint of the manner in which the Outer Hebrides are divided into three parts, a division which is also discernable in matters other than transport. Thus Lewis and Harris form one unit, with communications via Stornoway to Kyle of Lochalsh and Mallaig. Lochmaddy and especially Lochboisdale are the harbours for the Uists and Benbecula with connections to Mallaig; Castlebay on Barra is most closely connected with Oban. The link between Harris and North Uist is consequently rather weak, and the same may be said about the communications between Barra and South Uist. Stornoway, the only town in the Outer Hebrides, is not only a centre for Lewis, with daily bus connections to almost every part of the island, but also for Harris. Harris is connected with Stornoway by the relatively new road over the highest mountain area in the Outer Hebrides, which lies near Clisham. The maximum height of the road is about 600 ft. South Uist and Benbecula are already connected by a bridge, and in the near future North Uist and Benbecula will also be connected by a bridge. The consequence of this seems to be that Lochmaddy is likely to lose some traffic to Lochboisdale. The advantageous situation of South Uist and Lochboisdale from the point of view of communications to the mainland is emphasized by the fact that a guided missile range is going to be built on South Uist.

The roads of the Outer Hebrides are comparatively new everywhere. The rugged or peat covered terrain made the use of the cart almost impossible in earlier times, when ponies or women carried goods in creels made of willow. Now, rather good, mostly metalled but frequently too narrow roads connect almost every settlement. On the south-west side of Lewis there are a few townships without road connections. Since the end of the second world war, there has been a very rapid development of the road system, including the building of many new bridges, partly because road building has eased the unemployment problem.

Coastal transport by small boats to serve local needs, which seems in the past to have been very important means of communication, hardly exists now. The only exception is traffic to the smaller islands, for instance to Scalpay from Tarbert in Harris. A more detailed analysis of internal communications demands a few preparatory words about population and settlement, of which the WEST HIGHLAND SURVEY gives an excellent picture.

The most significant feature in the position of settlement is that it is almost wholly confined to the coastal tracts. With the exception of Achmore (Lochs, Lewis) not a single township seems to be more than a couple of miles from the shore. These features have been stressed by early as well as by more recent authors. On a world-wide scale, this type of distribution of settlement is com-

mon for barren areas. In the Outer Hebrides, the occurrence of this pattern of settlement has been predetermined on the one hand by the extreme infertility of the interior of the islands, and on the other by the situation of the best and most workable soils near the sea. In the past the sea has also been important to the local people as a source of fish and seaweed. Neither fishing, which at one time contributed very considerably to the maintenance of the population, nor seaweed gathering are as important as they once were. Even to-day, the inner parts of the islands are completely uninhabited and the best use for these large but barren areas has been, and still is, a problem of great importance. At the end of the last century the first road was built across these peaty wastes from Stornoway to Barvas on the west coast. For long distances, the settled coastal belt is rather wide, about 2 km. in fact, as for instance on the west coast of Lewis, from Ness in the north to Shawbost, although it is interrupted in places. It is particulary extensive in the southern islands, that is on the western coasts of Benbecula and the Uists, where it can be up to three kilometres wide. In the neighbourhood to the north and north-west of Stornoway and on the Eye Peninsula there are rather large, evenly settled areas. Settlement on the west coast has nowadays lost some of its former close connection with the sea and the shore. Here, the built-up areas and even the cultivated patches have been extending on their landward sides. At the same time, fishing has been declining in importance. By comparison, the more isolated and smaller units of settlement on the east coast have retained their situation in close proximity to the sea, because the more rugged terrain has prevented the spread of settlement to more sheltered places farther away from the coast.

The linking of the settlements by road has raised the problems both of overcoming or avoiding the mountainous areas, and of penetrating the labyrinth of lakes and sea lochs, which especially in the Uists present considerable obstacles. The drainage of the roads has evidently been very difficult, as their foundations lie partly on barren rocks and partly on deep peat, which besides being poorly drained, is unable to carry heavy traffic. Altogether, there are some 575 km. (350 miles) of roads in the Outer Hebrides. In 1945 THE LEWIS ASSOCIATION published a fairly detailed report of the state and development of the roads in Lewis. Some points from the report may be quoted and commented upon here.

The first road built from Stornoway to Barvas on the west coast, was begun in 1791 and completed in 1833. At the same time, Garynahine on Loch Roag was connected by road with Stornoway, while the northern road to Gress had already been opened in 1812. During Sir James Matheson's time, a great

number of roads were built. The only part of Lewis which was left without roads was the Loch Roag area. Between 1820 and 1878, road conditions were not considered worse than in other parts of Great Britain. There were also several proposals for building railways on Lewis, but these plans never came to fruition. Thus there was a project in the 1880's for connecting Carloway, at that time a flourishing fishing port, with Stornoway, but the importance of the place declined when trawlers from English and Scottish ports began to operate in local waters. Some years later, a railway to Tarbert was proposed. Finally, a narrow guage railway was included in one of Lord Leverhulme's many plans for the economic development of Lewis. The roads remain however, the only means of transport on Lewis as well as on the other islands.

The importance of roads in colonization may be illustrated by the following quotations from the report: »An interesting feature of the coming of the roads, and one still evident to-day, is the magnetic effect of the new roads upon the established villages. Along the coast and in the Eye Peninsula the focus of the villages moved from the coast to the vicinity of the road. It is probable also that some settlements between Ness and North Tolsta were abandoned in favour of a situation nearer to the Barvas—Ness road.» (p. 14) and further (p. 28—29) »The fact that houses in the older Lewis villages were built before the roads came into existence and without any reference to the road system, has created a difficult problem, especially in the Park district, where the ground is very broken, and it is almost impossible to site houses in any sort of alignment with each other. The result is that in some villages long stretches of road would have to be constructed to isolated houses, to make the road system to service the whole community. Once solved, however, that problem will not recur because all new houses are built conveniently near the main roads. In fact the extent of ribbon development in rural Lewis in the years between the wars was threatening to block the access to the common grazings in several of the villages, and was creating long straggling lines of houses instead of compact communities.»

Several forces prompted the development of the road network. Firstly, an intensification of the economic life of the islands followed the first world war and was accompanied by the introduction of motor vehicles. Secondly there was the expansion and organization of the Harris tweed industry, which gave an added impetus to the improvement of the road network. As secondary factors following the development of an economy based on money rather than on the exchange of goods, were the centralization of the trade in foodstuffs and the rural desire to benefit from the cultural and social possibilities of Stornoway. Finally a new need for roads in rural areas arose with the exhaustion of

peatbanks near to the home settlement. The new roads built for peat transport also facilitated the movement of seaweed, shell-sand and manure.

The report comments on changes in eating habits which followed the decline of subsistence agriculture and the centralization in the distribution of goods. »The effect on Island agriculture of improved transport facilities has been on the whole adverse» (p. 30) it observed. It is then added, however, that the improved communications should stimulate the cultivation of those crops which could be expected to have a good market in Stornoway, either directly as vegetables, or indirectly as eggs and milk. West coast fishing, especially for lobster at Loch Roag would probably be encouraged by improved transport, though the main problem here seems to be one of external communications. Goods traffic is equally hampered by the rugged terrain and scattered groups of settlement which adversely affect the passenger traffic. It is further affected by the difficulty of finding a return cargo from rural areas where few, if any industries exist. According to the report, more rapid and frequent road communications should counteract the tendency to rural depopulation which results from a considerable part of the rural population earning its living in Stornoway. To a large extent the roads have been built in order to relieve unemployment, which at times has been extensive.

2. RELIEF AND GEOLOGY

a. Rocks and Soils

The Outer Hebrides are composed primarily of Archaean rocks; gneisses, especially Lewisian gneiss, form the greater part of the islands. These gneisses are, however, broken in many places by intrusions of igneous rock, particularly granites, as for example in the mountains in the middle of Lewis (Ben Barvas, Ben Bragar) and in parts of Barra. Basaltic intrusions also occur (St. Kilda). This foundation of heavily metamorphosed rocks, which is thought to have a contemporaneous parallel in the Lofoten Islands of Norway is either entirely bare, or covered by a layer of peat. North-east of Stornoway, on either side of the inner part of Broad Bay, towards Gress in the west and Garrabost on the Eye Peninsula in the east, is an area of »Torridonian sandstone», which should be chronologically comparable with the late Archaean »Jotnian sandstones» of Fennoscandia. For the sake of completeness, it should be mentioned that the Shiant Isles are composed of Tertiary basalts. The essential point when we are considering the land-use, is that this gneiss-granite foundation weathers slowly and produces a very acid soil. The only exception is the area

with Torridonian sandstone where there is a deeper layer of primary soil. The rock foundation is highly impervious: surface run-off predominates. The drainage of roads and pockets of soil, which are perhaps cultivated, is very difficult. These geological characteristics are unfavourable to agriculture. They have been accentuated by the scouring action of the last ice-sheet, and by the development of a cold maritime climate in the post-glacial period. Drainage and soil development, which will be discussed later are also influenced by relief and climate.

Apart from peat, the most important soils are moraines and boulder clays, which form a thin layer, seldom more than 1 m deep, over the bedrock. The moraines frequently contain large boulders which diminish the possible agricultural value of these soils.

The irregularities of the relief make even these soils very difficult to drain. The greatest disadvantage however, is that the soil layer is too thin, and that it is frequently covered by a layer of peat. The peat blankets most of the surface, except on the steepest slopes, and often achieves a considerable thickness (2—4 m). It has evidently been formed under more favourable climatic conditions, and its great age is proved locally by a high degree of carbonization and deep erosion. However, it is also possible that human intervention played a considerable part in this change of the conditions which had been suited to peat formation. Thus the Vikings may have destroyed the birch forests, traces of which are frequently found in the peat. Further, it is probable that overgrazing of the heather and sedge cover started the erosion of the surface. The large expanses of peatland have other effects on the land-use. It is difficult to reclaim peat lands because they are deficient in phosphorus and calcium, both important substances for nourishing plant growth. Again, because of the physical characteristics of a peat area, it is difficult to use heavy agricultural implements or to graze it with heavy animals. An experiment in using modern methods to bring a peat bog under cultivation was sponsored by T. B. MacAulay at the beginning of 1930 in a district near Arnish Moor SW of Stornoway. It was however interrupted after some years, in spite of promising results (see W. G. Ogg and Angus Macleod, 1930, 1931 and 1932). Peatland in grass responds most rapidly following the introduction of species superior to those forming the natural plant cover. Its growth may be further improved by the use of a cheap manure, for example shellsand, and temporary protection against grazing or at least over-grazing. The expanse of peatland, with its great quantities of stored water, the drainage of which is impeded by the nature of the relief, has a secondary effect on the local or microclimate.

From time immemorial, peat has been used for fuel, and even today, the endless peat-banks are a striking feature of the landscape. This kind of land-use is in sharp contrast to the possibilities which the same areas present as potential regions for improved fodder production. Peat cutting exposes the subsoil which is as a rule a morainic soil with stones and boulders, weathered white by the acid in the peat. It may be simply bare rock. In both cases »skinned land» results; it is sometimes of an extremely barren character, and is expensive to improve. There are three types of skinned land: 1) Green type. The soil is a boulder-clay, very stony, but with a fairly uniform surface vegetation of sedges, marsh-grass and a little heather. The green turf is often stripped off by the crofters for a variety of purposes. — 2) Black type. As much as 2 feet of peat is left. Vegetation is of heather and bog-plants, but bare patches are frequent. — 3) Stony type. Stones and rocky outcrops are abundant; but it might be improved for grazing. W. G. Ogg & Angus Macleod 1930, p. 125.

Where peat cutting has covered the entire area and exposed the subsoil the result is a terrain in which the trenches from which the peat has been taken alternate with patches of bare earth or rock. Such tracts are best classified as »badlands» (see Fig. 2).

The cutting of peat is well described in the statistical account (1790, p. 161): »When they are making peats, five people are employed. One cuts the peat; another places it on the brink of the ditch where it is dug; a third spreads it on the field; a forth pairs and cleans the moss; and a fifth is resting, and ready to relieve the man that cuts. And thus the rounds are taken by turns. The women are seldom at this work, but the men help one another alternately; sometimes they must rest satisfied with fewer hands; but the above is the full complement required to perform the work, accordingly to their taste.»

The peat nearest to the settled area has been used first: the best banks are now situated some miles inland. They are divided from the settlement by a zone of deserted skinned land crossed by bad peat roads. Growing transport distances are gradually reducing the economic value of this fuel. The digging, drying and transport of the peat require much hand labour, which would also make the fuel expensive were it not that only members of the family are employed. Long distances also complicate the reclamation of used peatlands.

The use of peat as a fuel varies considerably in different parts of the Hebrides. Best situated in this respect are the villages on the north-west and north-east side of Lewis. One notices immediately that where there is a larger agglomeration of settlement, for instance in Barvas or in the neighbourhood of Stornoway, peat is not as important as coal. In Harris, largely because of the rugged relief peat cutting is on a smaller scale. In the Uists and Benbecula

there is again a considerable amount of peat cutting, especially on the western sides of the islands. Peat cutting displays an archaeic form of co-operation between the members of the township. It is an almost unique survival in which old tools persist, and from which little profit derives, but through which much social enjoyment is clearly obtained. Thus, peat is part of the poetry as well as the patrimony of the islands.

b. The Lie of the Land

The relief of the Outer Hebrides is controlled by four elements. The first is the Pre-Cambrian peneplain surface, which predominates especially in Lewis, except for its most southerly parts (i.e. North Harris), and on the western sides of North Uist, Benbecula and South Uist. Depending on the level of this surface, one finds two types of landscape. The first is characterized by lakes and penetrating sea inlets often rendered fiord-like by glacial action as in eastern North Uist. The second, where the peneplain has comparatively recently been uplifted is a landscape of marshes, lakes and slow-running waters. The cliff coast of N. W. and N. E. Lewis provides further evidence of this uplift.

Secondly, there are those parts of the ancient rock massif which were lifted by tectonic action above the level of the rest of the peneplain surface, and were then glacially sculptured during the last Ice-Age. Land of this type forms the highest parts of the Outer Hebrides, it occurs in southern Lewis, most of Harris, except the Minch

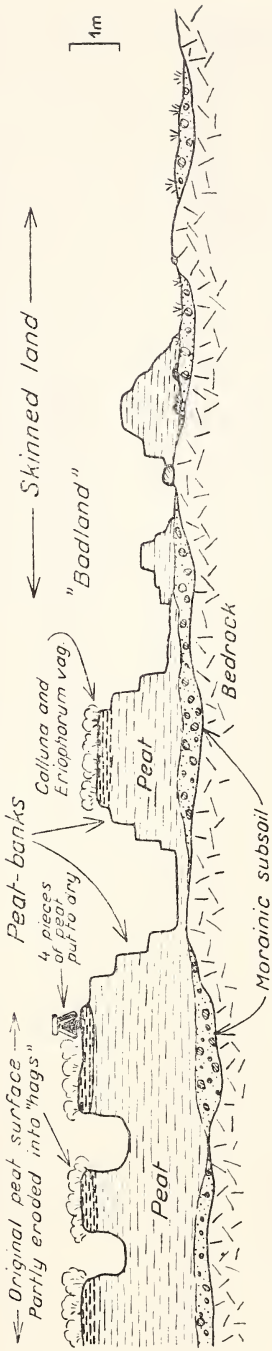

Fig. 2. Simplified section through the fringe of the peat area.

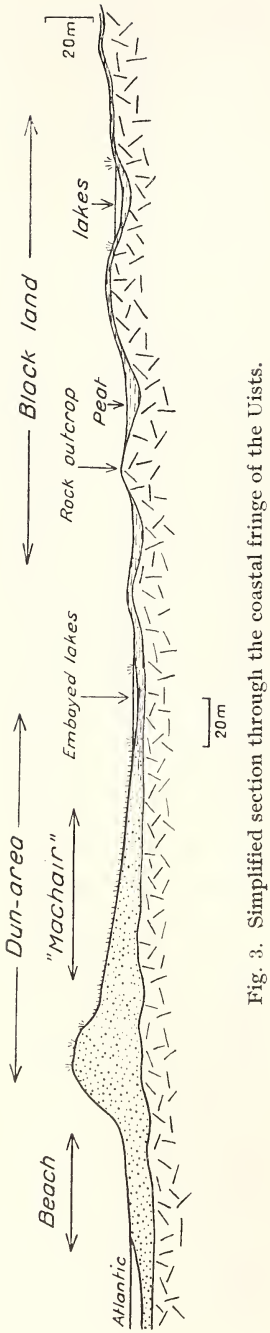

Fig. 3. Simplified section through the coastal fringe of the Uists.

coast — the »Bays», the eastern sides of the Uists and Benbecula, and most of Barra.

Thirdly there are the lines of tectonic weakness, which, in combination with glacial sculpturing have modified the general relief. They have been responsible especially for its details. The system of tectonic lines of weakness has been studied by Jehu and Craig (1924, 1925, 1926, 1927, 1934), J. W. Gregory (1927), W. Panzer (1928 a and b), A. Steers (1952), and S. Ting (1937), while the topographical features have been analysed by A. Geikie (1901), B. N. Peach and J. Horne (1907) and others.

The influence of ocean currents and the dominating westerly winds has been the fourth contributary factor in the development of the topography of the Outer Hebrides. Thus in many places along the west coast, well developed dune areas are to be found. For instance they occur in Barvas in Lewis, on some parts of the west coast of Harris, almost uninterruptedly along the west coasts of North Uist, Benbecula and South Uist and occasionally on the west coast of Barra. To these are added the numerous offshore-bars, sand accumulations and tombola formations which characterize the submerged west coast, see Fig. 3.

Panzer (W. Panzer 1928 b, p. 169, 174) has pointed out that the relief of the Outer Hebrides is characterized first by the evenness of the land forms (Ausgeglichenheit der Formen) and secondly by the fact that two major land forms: a) the mountains (Bergland) and b) the peneplain (Rumpffläche) stand in juxtaposition. In Lewis the peneplain covers an area of about 1.450 sq kms and lies at an altitude of 100 m. Many marine coastal terraces, partly preglacial, can be distinguished round the island of Lewis. There is a conspicuous terrace at 65 metres. The steep gradient of the rivers near the coast is also a sign of recent uplift.

The isolated mountains in central and north Lewis are described as »Restberge, Fernlinge» or »Inselberge» and not as structurally evolved »Härtlinge». About the multitude of lakes and the undeveloped drainage PANZER says: »Die Oberfläche steht in Widerspruch zu den fast überfeuchten Klima, unter dem sie liegt. Die Äusseren Hebriden zeigen allenthalben Vorzeitformen, die erst im Begriffe sind, sich an das heutige Klima anzupassen.» PANZER also stresses that the dipping strata of the pre-existing structure encouraged the development of »roche moutonnées».

The relief in combination with the dominant rain-bearing westerly winds has an adverse influence on the agricultural potentialities of the land. HANCE makes the following remarks about this (W. A. HANCE 1951, p. 76): »It is indeed unfortunate for the Hebrideans that the mountainous portions do not occur on the westward flanks as on the mainland of the British Isles. The general lack of protection from the prevailing winds and particularly from the winter gales is one of the greatest handicaps suffered by the islanders.»

The importance of topographical influence on the distribution of population, land-use and the development of the road network has already been mentioned. It is, however, worth noticing the division of the islands into parallel zones, which has been brought about by differences in relief and topography. For example, this is particularly well marked on the western sides of the southern islands. The zones illustrated in Fig. 22, p. 93, are: a) The *Machair*, or the dune zone which has comparatively dry sandy soil, shallow sea-bays, lagoons or lakes. b) The *Black land*, a zone of numerous lakes; rocks which are partly covered with a thin layer of moraine, or peat, the greater part of which has already been used. The black land is the main area of settlement. c) The *Gearraidh* or foothills, which have better, often the best pastures and which are predominately used for cattle. d) The *Monadh*, or the highest mountainous parts which yield a rough pasture and are chiefly used for sheep. Where the relief is greatly dissected (eg. in Scalpay, Harris), the natural conditions have necessitated intensive utilization of the few flat soil (or peat) filled pockets, while the houses climb the steep hillsides. In Harris and the Uists there is a considerable difference between the western Atlantic coast and the eastern Minch coast. This is chiefly dependant on the relief. The west is characterized by a flat or gently rolling topography, and the east by a broken terrain, with a confusion of islands, winding fiords, lakes, hillocks and valleys.

3. CLIMATE

»The land is rendered a desert of water by the climate» (STEVENS 1925, p. 79). This comment emphazies at the outset, the dominant role of humidity

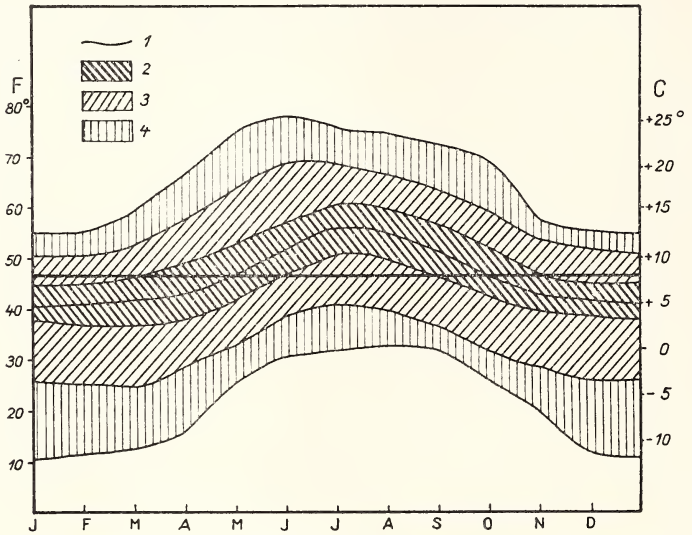

Fig. 4. Temperature at Stornoway. Heavy horizontal line = yearly mean temperature 1 = monthly mean, 2 = daily mean range, 3 = monthly mean range and 4 = monthly extreme range (until 1935).

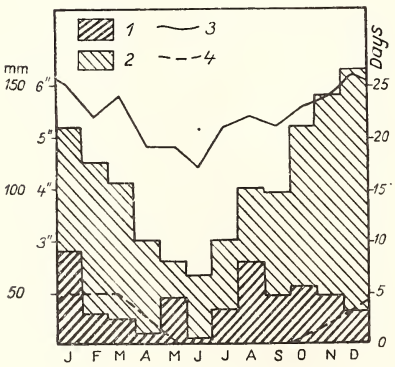

Fig. 5. Rainfall at Stornoway. 1 = Maximum in a day (until 1935), 2 = Monthly average (1881—1915). 3 = Number of days with rain (same period). 4 = Number of days with snow (same period).

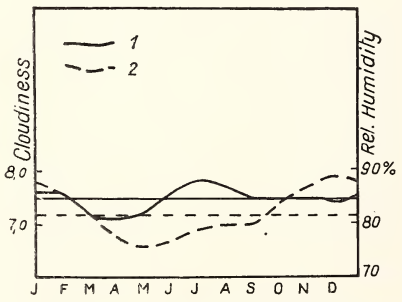

Fig. 6. 1 = Cloudiness in tenth of the sky covered (mean of 7h, 13h and 18h). 2 = Relative humidity (% at 13h). The yearly mean levels are also shown. Stornoway.

and precepitation in the life and nature of these islands. Wind, no less than rain, is a persistent affliction. The Hebridean climate will be discussed briefly below, with the help of five diagrams, in which some of the findings of E. G. Bilham (1938) are shown.

The temperature-graph (Fig. 4) for Stornoway shows no great variations. The daily and monthly ranges above the mean for the month are highest during the summer months, the greatest ranges below the mean are during the winter months. The mean of the daily range is 8°F, the yearly range about 14°F. According to Stevens, the January and February isotherm for 41°F. (+5°C) runs in NW—SE direction across Lewis, approximately across the widest part of the island between Great Bernera and Beinn Mohr. The isotherm for August (55°F or +13°C) runs almost parallel to the NW-coast of Lewis. The isotherm for the year (47°F or +8°C) runs almost in the same direction over Lewis as the isotherm for January—February (comp. also Fig. 1).

The rainfall can be seen in Fig. 5 (Stornoway). The yearly total is 49,9″ (1.965 mm) and the monthly precipitation varies between 6.3″ (248 mm) in December and 2.3″ (91 mm) in June. As a rule the precipitation comes in the

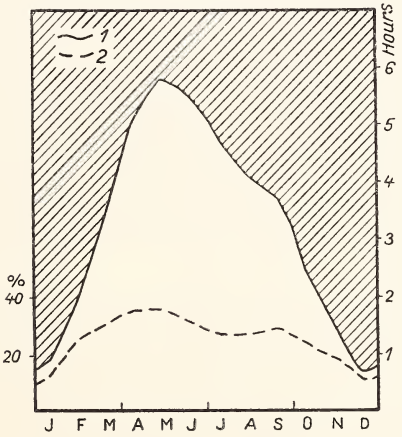

Fig. 7. Sunshine, 1 = hours per day, 2 = amount of sunshine as a % of that theoretically possible. Stornoway.

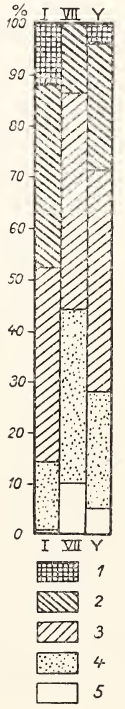

Fig. 8. Wind velocities at Butt of Lewis (6 years mean). 1 = More than 38 miles/hour (18.5 m/sec.), 2 = 25—38 m.p.h. (11—18.5 m/s), 3 = 13—24 m.p.h. (5.5—10.5 m/s), 4—4 = 12 m.p.h. (2—5 m/s), 5 = under 4 m.p.h. (2 m/s), I — January, VII = July, Y = yearly mean.

form of drizzling rain, and rainy days are very numerous, between 17 per month in June and 26 per month in December. The maximum precipitation per day is also shown in the diagram, as are the number of days with snow (Jan.—Feb.—March 5 days per month). According to STEVENS the precipitation varies between 40″ and 60″ per year and on the whole remains at about 50″. HANCE (1952) mentions as much as 70″ in the mountain areas of Harris. According to Bilham's map (BILHAM, Fig. 24) the northern part of the Hebrides (Butt of Lewis) and Barra Isle has an average of less than 40″ per year, the other parts between 40″ and 50″. See also Fig. 1. The mean deviation from the normal annual rainfall is smaller than for other parts of Great Britain and varies from more than 10 % in the eastern part of Lewis to 9—10 % in the western part of Lewis and Harris, 8—9 % in North Uist and Benbecula, and to below 8 % in South Uist and Barra. The total number of days with rainfall amounts to over 250 in eastern Lewis, to 225—250 in western Lewis and Harris, to 200—225 in North Uist and to below 200 in the area south of North Uist. During January—February and October—December most parts of the Outer Hebrides have at least 4″ of precipitation per month. In March, August and September this amount of rainfall is reached only in the eastern or highest parts of the islands. The annual range of cloudiness, humidity and the quantity of sunshine can be seen in Fig. 6 and Fig. 7. The complement of this is the scarcity of sunshine. STEVENS mentions only 1.270 hours of sunshine per year in Stornoway, which corresponds to 29 % of the total theoretically possible. On an average the Hebrides will get up to 3 $^1/_2$ hours of sunshine per day, the southernmost islands, that is the southern parts of South Uist and Barra get a little more. During the summer the occurrence of sunshine is 5 $^1/_2$—6 hours per day (the above mentioned southern areas get more than 6 hours per day) and in December an average of 0.5—1 hour per day is usual.

The average windspeed and storm frequency reach extremely high figures as may be seen in Fig. 8 for the Butt of Lewis; though this northernmost part of Lewis is perhaps somewhat more windy than the rest of the island. Southwesterly to westerly winds predominate and they have a decisive influence on the vegetation and on human activity. During late winter or early spring intrusions of cold polar air sometimes occur bringing with them easterly or northeasterly winds. These injure or at least retard the spring growth of vegetation. STEVENS mentions that winds of gale-force, 8 or more on the Beaufort scale, occur about 20 times a year, or during an average of 378 hours (BILHAM).

When the different parts of the Outer Hebrides are compared climatologically, a boundary can be drawn between a colder, damper and less sunny northern part and a climatically more favoured southern part. Barra and the south-

ern part of South Uist have a climate which is noticeably better than that of the rest of the Outer Hebrides. One can also distinguish between a somewhat dryer western zone and a more rainy eastern zone. On the whole this wetter eastern zone coincides with the mountainous districts.

Land-use, natural vegetation, different methods of cultivation, buildings and many features of the social life are deeply affected by aspects of micro- and macro-climate.

From the point of view of macro-climate the long frost-free period is of importance. It allows the different agricultural tasks to be distributed over a great part of the year, sometimes uninterruptedly throughout the winter. The period of vegetative growth is also unusually long, which is helpful for the cultivation of vegetables. The mean temperature and the »heat total» of the summer are however comparatively low. These factors combined with abundant and evenly distributed rainfall, have resulted in a very humid climate, which is unfavourable to grain cultivation and demands a special technique for every kind of cultivation. »Lazy-bed» cultivation, for example is the result of adaptation to climatic conditions.

The strong and frequent winds are also added disadvantages. They make tree growth almost impossible and retard the development of other types of vegetation. The wind causes mechanical damage to leaf and stem, and may also wither vegetation, especially during the spring. Salt from the sea is spread far over the islands. Locally there are more sheltered areas with better conditions for tree growth, for instance in the district west of Stornoway, where numerous foreign conifers have been planted and in the Breivig and Veenish valleys of Barra. Where suitable materials have been available dry-stone walls about 2 metres high have been built round the inbye-land and the most valuable areas of cultivation.

The Hebridean »black house» seems to be a perfect adaptation to environment. Its setting is adjusted to the slope. Its shape — low and »streamlined» — is a reflection of the strength of the westerly winds. The abundance of peat and the scarcity of wood are evident in its construction. The roof is of thatch, secured by rope, fishing net and boulders. To a visitor from Fennoscandia only one feature seems to have been forgotten, its absence was also observed by J. Mac Donald in 1811: »it is also surprising that in the Hebrides, a region so exposed to the inclemencies of the most boisterous climate in Europe, the obvious and simple accommodation of double windows is not adopted» (p. 84).

The great significance of the sky in the Hebridian landscape has been stressed by Panzer: »Endlos scheint die Öde, weil sie überall mit flacher Linie an den Himmel stösst. Gewaltig spannt der Himmel sich darüber, fast wie auf

den offenen Meer. Der Himmel ist ein wesentlicher Bestandteil dieser Landschaft. Seine Stimmung ist auch ihre Stimmung. Fast immer ist er bedeckt. So sind die Farben in der Landschaft fahl und stumpf.» (W. PANZER 1928 b, p. 40).

The mentality of the islanders probably reflects many of these aspects of the climate. The »impossible» weather easily induces fatalism or apathy. On the other hand it has encouraged social intercourse and the development of a contemplative turn of mind. This has resulted in an unusually rich treasury of folk-lore, passed from generation to generation during the »ceilidh» a gathering for story-telling, music and dancing during the long autumn and winter evenings. Perhaps the influence of climate may also be seen in the strong religious life, with its pronouncedly conservative features. The Outer Hebrides are Presbyterian, with the exception of South Uist and Barra which are Roman Catholic (Benbecula is 50 % Protestant, 50 % Catholic). Perhaps even certain purely negative characteristics such as intolerance, a dislike for, and mistrust of improvements, and alcoholism find some of their roots in the climate.

4. VEGETATION

The most remarkable feature in the vegetation of the Hebrides, shared by much of the western Highlands, is the complete treelessness. This gives the mountainous parts of Lewis, Harris and the Uists, and even more the gently rolling expanses of mid and north Lewis a singular appearance of desolation. The absence of woods allows wide views and diminishes the role of man and the results of his activities in the landscape, to insignificance. It makes the sight of the windswept sky and the drearily greybrown peat moors a heavy burden on the mind. Many parts of these islands have formerly been wooded, at least by low birchscrub and occasional pine trees, as can be seen from the frequent remnants in the peat of fragments of birch and pine. The woods may have been destroyed by the Vikings, but climatic changes may also have played a part in the fatal disturbance of the earlier biotic balance. It is certain however that centuries of heavy grazing by cattle and especially sheep struck the final blow and rendered the natural recovery of the forest impossible.

The treelessness has, apart from its influence on the climate, been of major importance in many respects of the human geography of the Outer Hebrides. The absence of wood has played a part in the development of the black house: its narrow shape, the weakness of the roof itself, the lack of height, the lack of timber for inner partitions, and the absence of beds and furniture. There has not been enough timber for proper tools, which has in turn led to a lack of

efficiency and a lack of either energy or a sense of time. There has not even been wood for fencing posts (comp. M. E. HARDY 1931, p. 34—35).

The creation of shelter for man, beast and crops however, is of primary importance and should be one of the first steps towards an improvement of the agricultural land or reclamation of new land. HARDY suggests the following sequence: 1) A stone dyke, 5 feet high, 2) Whin or gorse (*Ulex*), 3) *Betula pubescens* or *B. verrucosa*, 4) *Pinus montana*, 6) *Picea sitchensis*, *Larix leptolepis*, *L. Europaea* or *Thuja gigantea*. In the ground, there should be drains at intervals of 30 feet (M. E. HARDY, 1931, p. 34—35). The big North American Rhododendrons have also shown themselves to be adaptable to the Hebridean climate, as can be seen in the neighbourhood of Lewis castle.

Grazing has not only decisively altered the conditions for forest growth but also made an impact on almost every other form of vegetation. The only exceptions are small islands in the lakes, steep slopes and to some extent the boggy moors. The composition and appearance of the vegetation may have been considerably altered; nevertheless there exist several reasonably well defined vegetation regions.

The sandy parts of the coastal fringe support a dune-vegetation dominated by *Psamma arenaria* (Marram grass). Behind the dune belt there is usually a smoother area of sandy soil, sometimes more or less undulating where the irregular surface of the underlying rock has not been completely filled in. Here one finds the original »machair» vegetation, which is composed of a number of annual or biennial grasses, many leguminosae and *Bellis perennis*. These give the zone a singular appearance during the early summer. Water-logged patches, salt as well as fresh, are common in this zone; they are characterized by *Iris*, *Caltha* and *Armeria maritima*. This zone has developed only where the shore is sandy and level. In Lewis such a shore is comparatively rare, and occurs at only a few places on the west coast. Elsewhere a tall meadow vegetation is found above the more or less bare, rocky shore. As the meadows usually belong to the inbye-land of an adjacent township, the vegetation is protected from grazing during the first half of the summer and allowed to mature for hay. Different kinds of grasslike plants compose the vegetation here: *Molinia coerulea*, *Juncus*-, *Scirpus*- and *Carex*-species. This type of vegetation shows local modifications which are closely parallel to changes in the type and moisture content of the soil.

It can gradually pass into two other types of vegetation. Further inland, at low altitudes and on flat ground, it is transitional to boggy-moorland, or rather a fen type vegetation. These frequently tussocky moors provide the best grazing for cattle of breeds other than the Highland. Such areas occur

in flat, bowl-like depressions. Different species of *Carex* are the dominant element in their vegetation.

Secondly on poorer ground, especially where there is a thick layer of peat, which is often cut by erosion into high tussocks or »peat-hags», one finds a type of vegetation in which *Eriophorum vaginatum* is dominant, intermingled with some poor heather and low grasses or sedges. The capacity of this land to support sheep or cattle is obviously rather low. It improves a little where the slope is steeper, drainage better and the heather grows to a greater height. In the Scottish Highlands it is the usual practice to burn the heather every few years, but this is not done in the Hebrides. Hebridean moorlands with an unmixed vegetation of heather are rare, and are best developed on the south-eastern side of Lewis between Loch Seaforth and Loch Erisort (Geddes 1936). The steepest slopes and the areas of rock which have been washed more or less bare are occupied by a vegetation of low grasses or moss.

II. THE FABRIC OF THE ECONOMY

1. THE EMERGENCE OF THE HEBRIDEAN ECONOMY

At the beginning of the historical period, the population of the Outer Hebrides consisted of Gaelic Celts. Between 900 and 1265 they were conquered by the Norsemen, who are considered to have left certain traces in the mixture of races which forms the Hebridean population. The most conspicuous and lasting reminders of the Norwegian occupation however, are the place names of Norse origin which dominate almost everywhere. When the Vikings had been driven away, the Hebrides came under the feudal clan system, which had developed earlier in the Scottish Highlands. There arose a hierarchy consisting of the clan chieftans, their subordinate headmen and tenants (tacksmen) and the original population, who were tenants at will under the tacksmen. The patriarchial social system which was eventually established was based first on the need of the feudal chiefs to be able to summon up men for warfare, sometimes external, but more often internal. At such a time personal relationships were often more important than regional loyalties, so that it often happened that in internal feuds men from the same region fought against each other.

The peasantry strove to keep the area self-supporting with barley (bere) and oats for the people and fodder for the cattle, which were the most important export of the islands. On every farm all the land was held in common. The majority of the farms were directed by a tacksman, although some were held in common by joint-tenants holding directly of the chief. The cultivated land was divided into three parts or kvels, which were cultivated under a three-year rotation (2 years of oats, 1 of barley) with one manuring every three year. Each portion of the land was divided according to the ancient »run-rig» system so that the individual tenant (crofter) got his share in proportion to his rent. Rent was paid in agricultural products or more commonly in daily services on the land of the tacksman. The outfields were cultivated at long intervals (three harvests of oats and then fallow), see COLLIER 1953, p. 41—43.

This system came to an end in 1745, when the chiefs were reduced to the position of ordinary landowners. The result was that the chiefs no longer took their military resources into account, and for the first time demanded maximum rents for their land, i.e. rents according to its full productive value. The first result of these changing conditions was that the tacksmen who formed the »middle class» were obliged to emigrate and as they were relatively well off, they emigrated to North America. Conditions varied considerably in different parts of the Outer Hebrides. Thus in 1718 there were 64 big farms and 200 smaller tenants in rural Lewis, but by 1789 the greater part of the land was cultivated in direct tenancy to the landowner. The disappearance of the tacksmen meant that the peasantry were deprived of the leadership and inventiveness of a section of the population which could have advanced the economic development of agriculture and other industries. On the other hand, markedly individualistic tendencies among the population were strengthened (see COLLIER 1953, p. 43, THE LEWIS ASS. REP. N:o 7, p. 8).

In Harris and the southern islands the conditions which led to emigration were modified by the kelp-industry, that is the burning of dried seaweed to produce different salts, such as iodine, soda and potash. This activity had its first boom-period from the middle of 18th century, and made it possible for the tacksmen to keep their farms so that in Harris emigration was on a smaller scale than in Lewis. In North Uist there was a short wave of emigration between 1760 and 1775. In the last 5 years of this period 200 persons left for America (DAVIES 1956, p. 69). In Harris the first wave of emigration came even later, in 1820 when the economic value of the kelp industry rapidly declined as a result of the importation of cheaper foreign salts (Spanish barilla) and the inception of techno-chemical production (J. B. CAIRD 1951, p. 93). It is worth while stressing that the kelp-industry demanded much hand labour, though

only from mid June to mid August. The productivity of the industry was nevertheless so high that population exceeded the feeding capacity of the land in spite of the reclamation of much new land by the cultivation of potatoes, which were introduced at the time of the first kelp boom.

A vivid picture of the uncertain life of the crofters in the days of the tacksmen can be obtained from ANDERSON's description (J. ANDERSON 1785, p. 19—23):

»Those capital branches of employment, which, in other circumstances, might, if persevered in, furnish the means of a comfortable subsistence, must be so frequently interrupted by those other unprofitable, though unavoidable vocations, that it turns out to be of very little benefit to them. And men who observe very little more of the mode of life of these persons, save that they frequently desert those employments that such observers think would turn out profitable to them, rashly conclude, that this proceeds from an unsteady disposition, and the poor people are cruelly insulted and abused, instead of being tenderly sympathised with, and kindly supported and cherished. Yet, though suffering, they complain not, but submit to their hard fate with a patient resignation; which strongly indicates that their hearts are uncorrupted, and that they may be easily led to undertake any useful employment that might be put within their reach.

From these causes, were none other to co-operate with them, the fishery never could be carried on by men so circumstanced, with advantage, and being unable to purchase boats and other apparatus for the fishery, they are obliged to rely upon the *soil,* as the surest means of finding subsistence. Little *possessions* (for *farms* they cannot be called) are sought after by them, with an avidity that is scarcely conceivable; and they cling to these with a degree of eagerness, which the wretchedness of their enjoyments would not seem to authorize. The tenure by which those poor people hold these, is short and precarious, usually from year to year only; but sometimes it is extended to *seven* years, which is the longest term of a lease they ever obtain. Being thus continually in danger of being turned out by their superior, who for the most part is himself only a tenant, they are obliged to submit to almost any conditions he pleases to impose upon them, which tends to render their lot still more uncomfortable than otherways it would have been.

This extreme dependence of the people of all these coasts upon the land, has suggested the idea to the possessors of it, in *some* places near the sea-shore, of making the poor people pursue the fishing for the profit of the superiors only. With this in view, these superiors furnish to their immediate dependents, boats, and the necessary apparatus for fishing, for which they charge whatever rates they think proper to impose. They also lay in oatmeal, and other necessaries, which they give out to their dependents in small proportions as it is wanted, at what prices they please to exact. To obtain payment for these articles, they take the people bound to go out afishing as often as possible and (in some cases even upon oath) not to sell to any other person any part of the fish they shall catch, but to bring them all to their superior, who agrees to take the whole at a certain stipulated price, of his own making also. By such means, some of those superiors have contrived to squeeze the poor people to the utmost degree they can possibly bear, and usually arrange matters so as to get them into debt, so that they could lay hold of their little *all,* should they happen to disoblige them. The poor people are thus unable to find the means of emigrating to other countries, and dare not propose even to alter their situation at home, lest they might

thus provoke their master to strip them of their all. They thus live in a state of hopeless indigence, and abject dependence, than which nothing worse can be well conceived. — Compared with these fishermen, the people within land think themselves happy, which makes them shun the shores, and as much as possible avoid entering into the fishing, tho' necessity frequently brings them to the rocks to fish with a rod for their own subsistence and to gather shell-fish among the stones which, on many occasions, has saved the lives of thousands.»

The second stage in development began when the landowners, now often resident in the big cities of Scotland or England, became convinced that they could not get a sufficiently high rent from their land under the existing system of tenancy, and that these lands would yield a higher rent if they were used for sheep farming. This led to a clearence of wide areas, which was in part voluntary and in part carried out under the orders of the landowners. The cleared land was used instead for sheepwalks and inhabited by only a sparse population of shepherds. WALKER's opinion on sheep farming was that »there is, to be sure, no way of raising the produce of the soil, in any country, with a few people, as by this method. A stock of black cattle requires many hands, both for tillage and for the dairy. A sheep-farmer on the hills of the south of Scotland, or of the north, requires neither of these, but can live and make riches in a desert, with his sheep and a very few servants. The introduction of the sheep farming, therefore, upon a large scale, must everywhere be destructive to population. Wherever it takes place, if the country has any inhabitants at all, they must, to a trifle, be expelled» (J. WALKER 1812, p. 407). On the other hand he remarks (p. 410) that »the true capital of a nation consists in its number of people, nor can any capital or wealth compensate for the want of people». He also mentions the great risks and the outlays of capital at high interest, connected with sheep-farming.

Because the peasant population who had been driven out lacked capital, they emigrated this time not so much to America as to the growing industrial cities in the lowlands of Scotland. Sometimes they moved to those parts of the islands which were not being used for sheep-rearing; for instance in Harris to the eastern parts of the island, the »Bays» (J. B. CAIRD 1951, p. 94 and map, Fig. 1), in North Uist again the former shielings were permanently settled (G. L. DAVIES 1956, p. 71). The rapid increase in population during the later 18th and earlier 19th centuries was connected with a number of additional factors. First the introduction of inoculation against smallpox, the rise of the kelp-industry and the adoption of potato cultivation which was introduced from Ireland to South Uist in 1743. The potato cultivation gave, as COLLIER stresses, a better crop per unit of land area than cereals and in this way raised the ulation potential of the area. Also it made it possible to cultivate by the

»lazy-bed» method (feannagan) grass-covered peatlands, which until then had not been touched by the plough (see below p. 44). This made it possible for the population to move out to those parts of the islands (eg. eastern Harris) which had never previously been settled. Fishing also contributed considerably to the maintenance of a large population.

This period of rising economic standards gave place however, at the end of the Napoleonic wars to a period of sharp decline, made still worse by several failures of the potato harvest in the middle of the 19th century. A decline in population resulted, which has been continuous with the exception of a short period between 1860, and 1880, when there was a final boom in the production of iodine from kelp (see G. L. Davies 1956, p. 70). In Lewis, where because of a lack of suitable shores the kelp-industry never attained any importance, the development of the population followed somewhat different lines. The increase in the population during the 18th and 19th centuries was much slower than on the more southerly islands, but the periods of sharp decline were lacking. Population growth continued evenly until the beginning of the 1920's, when Lord Leverhulme's extensive economic plans for Lewis broke down. The growth in Lewis more than compensated for the decline in other parts of the Outer Hebrides and in 1901 the total population attained its maximum of 46.200 with Lewis claiming 29.000 (A. Geddes 1955, p. 94—95). During the later part of the 19th century the large scale sheep-farming in the Hebrides also declined because competition from trans-oceanic countries, such as Australia, made it unprofitable. The earlier sheepwalks were used for sporting purposes. A considerable resettlement of the old areas was also carried out (J. B. Caird 1953, p. 97). Partly as a result of rather heated controversy on the social conditions of the Highlands and Islands, several official attempts were made to improve the position of the native crofting population and to safeguard it from economic oppression. The rents of the land were fixed, and the crofters, who had earlier been tenants at will were granted heritable security of tenure for their crofts. In this way the situation was stabilized, though much of the old system of land tenure survived. Such medieval features as the »run-rig» system persisted on the outfields of the machair land: though the inbye-land was thrown open for common sheep-pasture during winter, and many of the details of the economic structure continued unchanged. Even sheep-rearing retained much of its importance although it came into the hands of the crofters. Many features in the existing situation have their explanation in these two circumstances: the ancient system of land division and ownership, and the old inherited methods of land-use, with sheep-rearing playing too prominent a part. These matters will be discussed later, but it is appropri-

ate to stress here that sheep-rearing became intimately related with other means of livelihood such as fishing, work in the merchant navy, weaving and occasional work on the roads. In most cases these activities have frequently been of greater importance than the subsistence derived directly from the croft. The rise of sheep-rearing has also been closely connected with the decrease in population. These conditions have temporarily or permanently diminished the reserve of labour on the crofts, and have thus maintained or strengthened the position of sheep-rearing which requires much less labour than cattle-rearing or other, more intensive, forms of agriculture. As it has been difficult to alter prevailing conditions in any way which is consistent with the maintenance of a sound economy, the government has been obliged to support, by means of subsidies for sheep, this method of using the available natural resources, although it is in so many respects destructive rather than constructive. These sheep-subsidies were however terminated in 1954.

2. POPULATION AND SETTLEMENT

The population and settlement of the Outer Hebrides show a number of remarkable characteristics. These features stand in marked contrast to conditions prevailing in the western Highlands of Scotland. Thus, even to-day, the Outer Hebrides have a much greater population density than the West Highlands, the growth of population has continued until this century and the emigration has to a considerable extent, been of a semipermanent character.

The population density of the Outer Hebrides compared with the western mainland of Scotland is illustrated by the following table from WEST HIGHLAND SURVEY (p. 110—111):

Tab. 2. Population Density of the Outer Hebrides

West Highland [1]), acc. »W.H.S.», excl. 4 larger towns 1951	11.2	Persons per Sq. mile	= 4.3	per Sq. km
North Hebrides	33.4	—»—	= 12.9	» » »
Parish of Barvas (Lewis)	33.5	—»—	= 13.0	» » »
» » Uig »	13.5	—»—	= 5.2	» » »
» » Lochs »	17.4	—»—	= 6.7	» » »
Stornoway	128.3	—»—	= 49.5	» » »
Stornoway landward	80.2	—»—	= 31.0	» » »
North Hebrides, excl. Stornoway Burgh.	27.6	—»—	= 10.6	» » »
South Hebrides	26.8	—»—	= 10.4	» » »
North Uist	18.8	—»—	= 7.4	» » »
Benbecula and South Uist	26.7	—»—	= 10.3	» » »
Barra	54.3	—»—	= 20.9	» » »

[1] See p. 52.

A detailed study of population and settlement has been made by W. A. Hance (1949), who has also described land-use and housing (1951, 1952). The background to the comparatively high density of population must be sought in the fact that in the Outer Hebrides there is more easily cultivable machair land than elsewhere. As well as this there has been the support derived from the relatively profitable fishing, kelp and weaving industries. However, these activities alone do not provide sufficient explanation for the considerable density of the population, nor the fact that the increase in the population has been comparatively steady until the present time. Thus the rural districts of the northern Hebrides first attained their maximum population in 1911. Development in the southern Hebrides has not been so satisfactory, the maximum there had already occurred in 1841. Collier gives a rather detailed analysis of the development of the population in the Highlands and Islands of Scotland (1953, p. 128—144) and comes to the conclusion that it tends towards stabilization. This is based on the fact that the net reproduction rate is near 1 and may exceed 1 if a sounder economic basis which would allow earlier marriages, is achieved. He assumes that emigration will stay at a rather low level as »a pressure of population no longer exists». On the other hand a contemporary »wave of nostalgic land hunger» just as after the first world war, brought people back to their place of birth. The structure of the population with regard to the age-groups has changed strikingly and shows a domination of the older groups, which in time, will retard the natural increase in population. Everywhere in the Hebrides one gets the impression of the mobility of young people and especially of the girls. In fact, about 50—60 % of them permanently or periodically go away to the mainland in search of a livelihood and many of the men are at sea. As an illustration of depopulation, there were 81 pupils in the school on Scalpay (Harris) in the spring 1956 against 150 a decade ago. On the other hand there is a rather lively building activity supported by special grants and loans, both in the countryside and especially in the larger centres of population.

The pattern of the settlements has also been touched upon earlier. The villages or townships have differing layout depending on whether they have been planned or not. If planned, the houses stand in a row on one or both sides of the road with the inbye-land in a long rectangle with its short side towards the road. In settlements of greater age, or where the terrain is dissected, a more irregular positioning of the houses and the land of the crofts is found. The pattern of settlement in Harris has been analysed in detail by J. B. Caird (1951). North Uist, Benbecula and South Uist have a comparatively dispersed settlement; agglomerated settlements of an almost urban type such as those

on the western side of Lewis are very rare here. About the situation of the crofting villages and settlements near the coast in the Outer Isles, HANCE (W. A. HANCE 1951, p. 79) stresses the importance of fishing, the better soil and better drainage and proximity to fertilizers (shell-sand and sea-weed) and concludes »In the location of the crofting settlements it has seldom been possible to consider aspects of slope and protection from the wind. Character of the soil has been the chief locating factor, and most of the best soils occur, unfortunately, in the exposed parts of the islands.»

The different types of housing have been the object of several studies. This is especially the case of the old Hebridian »black-house», which has been described many times (comp. R. W. BUCHANAN 1883, H. F. CAMPBELL 1920, WERNER KISSLING 1943, 1944, AAGE ROUSSELL 1934, ARTHUR GEDDES 1936, E. CECIL CURWEN 1938, A. H. KAMPP 1938, W. C. HANCE 1951, and several official reports). The black-house represents a type of housing, which is excellently adapted to the landscape and the natural conditions, but which has hygienic drawbacks, for instance the drainage of the earthern floor, lack of ventilation and light. It has been replaced by more up to date houses (white houses) which are however not so suitable in other respects. They are sometimes draughty and have noisy roofs. Nowadays one still finds black-houses in use, especially in Lewis on the W coast and Harris on the E coast. In the southern Hebrides there is a more modern variant of the black-house, with walls of cut stones, windows, chimneys and a straw roof reaching to the outer edge of the wall. »Within the crofting settlements» — as HANCE has put it (HANCE 1951, p. 80) — »the actual sites for the houses have been selected when possible, with a view to preserving the best land for cultivation or pasture. Little regard for drainage or other conveniences is evident; — — —».

The black-house was important in maintaining the fertility of the arable land, as the manure of the cattle was stored indoors all winter, sheltered from rain and wind, and also because the straw thatch was yearly replaced by a new one, and the old, smoke and ammonium impregnated thatch was used as manure on the arable land. Now the care of the manure is often very unsatisfactory, as it is stored outside the brick or concrete byre. In addition to the straw of barley (bere) and oats pulled by hand, the following plants have been used for thatching: sweet grass (*Zostera marina*), *Arundo arenaria*, *Scirpus lacustris*, *Phragmites communis*, *Pteris aquilina* and heather (*Calluna vulgaris*), J. WALKER 1812, p. 365—368.

Another feature of the old type of settlement and land-use was the temporarily inhabited summer house or shieling, of which only sparse and rapidly deteriorating remnants are left. These shielings on the interior peat land

were usually situated at a somewhat higher altitude where, thanks to better drainage and manuring by the cattle the grass was more luxuriant. The sites of old shielings are still very obvious as green patches in the brown gray expanses of the peatlands. This system of trans-humance was connected with a primitive dairying industry and the need to conserve the pastures of the coastal area for the production of winter fodder. A special kind of cheese was made at the shielings, characterized by the Ettric Shepherd as »hard as wood» (J. Hogg, 1881). As the sheep replaced the earlier, more numerous cattle these seasonal movements became unnecessary. Not even today, when there has been a revival of the keeping of cattle, it has been necessary to return to the use of the shielings, for most of the cattle are bred for beef, and do not need daily care. Also, improved communications have tended to make seasonal migration unnecessary. Stevens (1925) shows on a map (p. 76) the most important sites for shielings in Lewis. There has also been a type of agglomerated shieling settlement, with sometimes more than 20 huts of earth and stone situated in close proximity. A long abandoned remnant of this kind of settlement is found in North Uist, where the shieling system was discontinued before 1900.

There are a few densely populated places, with a type of settlement which resembles that found in a large town. Except for Stornoway they are relatively small and have usually only one short section of road with a really town-like type of settlement. They are Tarbert (Harris), Lochmaddy (North Uist), Lochboisdale (South Uist) and some places associated with the fishing-industry, such as Leverburgh, Scalpay (Harris) and Castlebay (Barra).

Geddes states in his study of the town (1947) that three stages can be discerned in the development of Stornoway. The oldest part lies on a small peninsula, Point Peninsula, with the castle of MacLeod at its outermost edge and the church of St Lennan nearer the mainland. The houses had their gables towards the only street, which is still preserved to-day (Point street). The castle and the church have long since disappeared, as has the fort which Cromwell is said to have built across the isthmus of the peninsula. During Seaforth's time, at the beginning of the 18th century, the town grew and settlement spread to the other side of the isthmus and along the shores. The third stage in the development occured during the period between 1820 and 1920 when the town attained an even greater importance as a fishing-harbour. A rectangular plan for the town was followed, although there were proposals for its modification. This layout had its roots in the old system of land tenure and Lewis castle also dates from this period. Sir James Matheson began to build it when he bought Lewis in 1844. The castle was finished in 1870 and was

later acquired by Lord Leverhulme and finally given to the town (Stornoway Trust) in 1925. It is nowadays used as a residential technical school, giving instruction in navigation, fishing, building, light engineering, textiles and weaving. Signs of a new wave of development were discernable after 1918 when Lord Leverhulme tried to concentrate the Lewis' fishing industry at Stornoway. The very last stage in the development of Stornoway is connected with the rise of the Harris tweed industry at the beginning of the nineteen-forties, which has led to a considerable building of industrial premises and workers' houses, centred especially on the area ESE of the town (Fig. 26). As well as the technical school, the town also has a large secondary school with 1.400 pupils, and the Matheson Institute, which is partly residential. As the town is surrounded by the best agricultural land in Lewis and as the supply of milk and fresh vegetables is sadly inadequate, much of it being imported from the Moray Firth district on the mainland, efforts have been made to prevent the spread of new settlement on to good agricultural land. There has been a shortage of housing in the town and the result is that a great many of its workers are daily commuters, using the rather frequent bus connections with the surrounding countryside. Also, the organization of the Harris Tweed industry is mainly aimed at keeping the rural population occupied in their homes where the weaving is done with factory-made yarn. In order to be able to mark the tweed as handwoven, the weaving must be organized in this manner. The chief importance of the town, today, when the importance of fishing has declined, lies in the tweed industry, and in its function as a centre of commercial and social activities for Lewis. The countryside is supplied now by a great variety of more or less manufactured foods, imported from the mainland, and distributed by vans from Stornoway. The town is also the dominant centre for social and cultural amenities and activities. The number of licensed premises, 7, is often commented on and must be seen in relation to conditions in the countryside, where there are no public houses. The future development of Stornoway is on rather uncertain ground: the tweed industry is very restricted and depends on imported fuel and also on imported wool, up to 6/7 of the total used coming from outside the islands.

3. THE ECONOMY OF TODAY

a. The Outlines

»*Highlanders and Islesmen are among the last, and perhaps the least changed, representatives of that peasantry which at one time inhabited much of Britain.*» (Collier 1953, p. 5).

The outer framework of the economy is the physical environment and situation; the inner, the people, their history and pattern of settlement. In order to get a fuller picture of the inner framework it seems to be appropriate to quote some of COLLIER's excellent observations. At the outset he says:

»The essential character of crofting lies in the fact that it is not specialized farming or fishing or labouring but combines something of each in a typical year's activity.

But perhaps the most vivid of all the observer's impressions is a sense of remoteness. It is not simply that the visitor is impressed by the hours he has spent jolting over bumpy roads, or on the deck of a small steamer interminably halting at small piers and jetties. It is more than a mere sense of remoteness in space that strikes him; it is a sense also of remoteness in time. He has stepped from a modern highly industrialized society in which each is producing for others rather than himself and dependent on others for the satisfaction of his own needs, to one more primitive in which, despite recent changes, the family group is much more self-contained and self-sufficient than in any town.» (COLLIER 1953, p. 6).

Speaking of the township COLLIER stresses the homogenity of the community and the pressure on the land:

»Two features of crofting townships usually strike the observer. The first is the similarity of all holdings. — — — they are all essentially of the same sort; at least nine-tenths of the people in a township are of the same economic status and — — — there is a pattern in the variation common to most.

Secondly, almost all crofting townships, even the largest of them, give the impression of having become congested, confined as they are by natural boundaries or neighbouring estates. Even knowledge of the important part played in the economy of the community by the seemingly barren common grazings on the hill does not dissipate this impression.» (COLLIER 1953, p. 33)

Finally COLLIER gives a description of the character of the Highlander. He says that their individualism is a result of isolation, this must be understood to be true only on a large scale, because the internal contacts of the Gaelic crofting townships are very vivid.

»The Highlander is frequently called an individualist. The term is usually employed as an implied criticism but contains a large measure of truth. Environment and individualism are closely linked. Individualism is to be expected in a country in which the scarcity

of cultivable land is responsible for the segregation of people in small and separate communities where the specialization of individuals in different types of production is impracticable. Differentiation of the economy involves a greater degree of economic elbow-room than exists in communities like the Highlands where the family is the working unit and where the pinch of necessity is severely and continually felt. Each man (and woman) must discharge nearly the whole range of tasks called for by the requirements of the croft life. Moreover, the degree of privacy and indeed, solitude, enforced on most Highlanders by their environment and method of earning a livelihood, and conversely, the lack of social contacts to enable exchange of ideas and the process of assimilation, imply a high degree of individualization and the existence of strongly developed personal differences.

— — — The Highlander's thought has a different orientation and content. It is meditative rather than analytic, imaginative but not inventive, concerned with the past rather than with the future, with self-cultivation rather than control over material environment and with integration rather than efficiency or acquisition.» (COLLIER 1953, p. 7).

The origin of the townships is not fully understood: it may lie in kinship groups settling on an area of arable and pasture land co-operating in common tasks (J. B. CAIRD 1951). Although the different kinds of team-work performed by the whole township have disappeared, there still exists nowadays with a few exceptions the old pattern of equality, and remnants of the communal spirit. The conditions of tenure are still generally very uniform through the Outer Hebrides and cause a uniformity of economic and social conditions, with very few persons or families above or below the mean level. The size of the crofts and the occupations of the crofters are uniform over wide areas. There are regional differences, examples of which are given in WEST HIGHLAND SURVEY, p. 292, where the sizes of the crofts are diagrammatically given for Stornoway parish, Harris and South Uist (Benbecula). Thus one is able to come, with relative certainity to some conclusions about the economy of an area and the distribution of the total income among the individual holdings. Such estimates have been put forward by others, thus HANCE mentions (1952) that the Lewis Association calculated the total value of the agricultural production in 1938 to be roughly £ 195.055 or £ 49 per croft. At the same time the value of the fishing was estimated at £ 261.529 and the value of the production of the tweed industry at £ 307.024. HANCE added that crofting thus ranked third and that the importance of crofting since then has still further diminished. However it is to be noted that the fishing nowadays is a subsidiary occupation for only a small number of crofters.[1] The value of the produce of the tweed industry is however more evenly distributed in Lewis, as the weaving of the tweed is put out to a great number of crofts. THE LEWIS ASSOCIATION REPORT N:o 7, »Agriculture»

[1] Comp. p. 56.

(1954?) gives a new estimate of the value of the agricultural production on Lewis and arrives at a net production value of £ 325.607 or £ 92 2 0 per croft, adding that the crofter will get only a small part of this in cash. COLLIER also gives an economic analysis of some crofting townships, including some in the Outer Hebrides (one in North Uist, one in Harris). The township investigated in Harris consisted of 8 crofts, the average area of the inbye-land was 4 acres. In the Harris township the produce of the croft consumed at home is estimated to be worth £ 60—65 and the produce sold brings in £ 35. The chief subsidiary income comes from fishing, and amounts to £ 40—65 per family. The average income per family is £ 182 10 0, the highest in £ 225, and the lowest is £ 155. The North Uist township quoted has 11 crofts and a number of squatters. In spite of the fact that the crofts are of the same size and are cultivated in the same manner there are differences in income. On an average one croft yields produce worth £ 135 of which £ 85 is consumed at home and £ 50 sold. This part of the income is uniform for all crofts, but in contrast to this, the subsidiary incomes vary considerably. Thus the average income per family amounts to £ 208, or between £ 235 and £ 158 in one year. Since the war (1939) a number of government subsidies have been added, of which the LEWIS ASSOCIATION REPORT N:o 7 (p. 22) says:

»The Grassland Ploughing Scheme came into operation a year or more before the outbreak of war. Under this scheme, a crofter was paid £ 2 an acre for ploughing up old grassland for cropping. The result was that considerable areas of old grassland were brought back under the plough, while at the same time, much of the arable land went out of cultivation. By 1944 the total tillage acreage in Lewis was less than in 1939. Nevertheless, the scheme did some good in the Island as it brought strong, fresh land under crops, and helped to extend the practice of rotation of crops.

Of the Potato Subsidy Scheme it cannot be said that it did any permanent good in the Island. Under this scheme, an annual payment of £ 10 an acre, later increased to £ 12, was made to growers. — — — Few crofters sold potatoes, — — —. The subsidy was therefore a gift which came to the crofter unsought and unexpected, and it did little to increase the output.

The Hill Sheep and Cattle Subsidy Schemes also came to the crofters as windfalls, unsought and unexpected. They consist of cash payments which in the case of sheep have varied from year to year from nil to 16/— per breeding ewe, and in the case of cattle are now £ 10 per cow. Cash subsidies are also given for calves reared to the age of 8 months. The amounts formerly were £ 3 for a female and £ 4 for a male. Now it is £ 5 for all beef-type calves reared. — — — In the case of a Lewis crofter, the subsidies did not augment his income to such an extent as to be real inducement to improvement of land or increase of stock. — — — The trend in the cattle population has been steadily downwards in recent years, and few cows have been reared except as a replacement for old cows. The increase that has taken place in the sheep population of the islands may be partly due to

the subsidy, but the importance of wool during the recent boom in Harris tweed may have largely contributed to this result.»

Thus these subsidies have not been able to arrest the downward trend which has prevailed in the agriculture of the Outer Hebrides during the past few decades. It may be seen that until recent times there has been a decline in the extent of the cultivated area in Lewis and also in the intensity of cultivation. On this island, although the number of animals has steadily decreased, the breed has been improved for the production of milk. The number of sheep has increased in spite of the fact that the islands have been considerably overstocked for some time, and this has been commented upon in several connections (for instance F. DARLING, WEST HIGHLAND SURVEY, p. 231, 236). As much as 6/7 of the wool for the tweed industry centred on Stornoway, is imported, and the industry could well withstand a reduction in the supply of local wool. Any such reduction in the number of sheep on the islands would undoubtedly lead to an improvement in the condition of the pastures. In Harris, the tweed industry, organized as it is on Lewis, plays a much smaller part. There is a carding and spinning mill in Tarbert. The crofts are better kept and apparently yield a bigger proportion of the total family income than in Lewis. The fishing and other subsidiary occupations, for instance work on roads and water pipes, and work away from the islands play a bigger part than in Lewis. In the southern Hebrides the occurrence of machair makes a difference; it is utilized as pasture for the cattle and for the production of cereals (fodder). The sheep/cattle ratio here has been more stable than in the Northern Hebrides.

Finally, it is appropriate to stress that the favoured position of the crofter nowadays with regard to rent and taxation has played an important part in the maintenance of the whole structure. Thus they resisted Lord Leverhulme's offer to make them a gift of their rented land and recently proposals for special tax of £ 4—8 per year on the weaving-shed have aroused much opposition (STORNOWAY GAZETTE 1956, 8/5).

b. The Crofting Constituent

Crofting represents a form of land tenure which has survived from medieval times until the present day. It is a case of tenant-farming where the unit of land is small and held since the early nineteenth century by the individual. The dwelling and byre lie on the small cultivated area, the inbye-land, and each tenant also has the right to a proportional share in the cultivated common land of the town-ship and the right to keep a proportional number of cattle, sheep and horses,

the souming [1], on the common grazing. The proportion in each case is decided in relation to the area of the inbye-land of the croft. In those parts of Scotland where crofting is found, there are many differences in land-use. The crofting districts are roughly equivalent to the »Highlands and Islands», and their boundary, according to COLLIER (1953, p. 11) »follows the main watershed from Loch Long to the Cairngorms, and thence strikes along the last line of high peaks to Inverness». It is particularly the area around Moray Firth, which because of low and even relief and fertile soil differs considerably from other parts of the seven »crofting counties» (Argyllshire, Inverness-shire, Ross and Cromarty, Sutherland, Caithness, the Orkney Islands and the Shetland Islands). For the sake of comparison, it may be worth while mentioning that the crofting districts cover an area of 14.000 sq. mls. or 44.260 sq. kms., that is 47 % of the total land area of Scotland. Nevertheless it includes only 7.5 % of the arable area of Scotland. The population of this crofting area was, in 1951, about 280.000 persons, of whom 90.000 lived on the islands. Of the real crofting population, which COLLIER estimated in 1953 to be about 80.000 and to which there should be added another 60.000 persons of similar status (fishermen, squatters, shepherds), 2/3 live on islands and only 1/3 on the mainland. The problems connected with the crofting population are, as COLLIER says, »on a small scale» and »largely an insular problem». (p. 142). Generally, »over the greater part of the area, a social and economic hierarchy can scarcely be said to exist. What we have is a small class of landowners, mostly non-native and partly absentee, a large and fairly homogeneous peasantry, and few opportunities for individuals to climb the social ladder except in the professions.» (COLLIER 1953, p. 5).

In the Outer Hebrides, because of the scarcity of arable land and the comparatively high density of population, the individual holdings are very small. HANCE (1952) says that 49.3 % of the holdings are up to five acres (about 2 ha.) in area. For the whole area covered by the WEST HIGHLAND SURVEY, the corresponding percentage is 44. Of the crofts 37.6 % are between

[1] »Souming in the township may be so much stock per croft, half-croft, or quater-croft, so much stock per one pound sterling of rent, or so many shares per croft in the common grazing. Some examples may be given: Dalmore in the parish of Barvas, Lewis, has a souming of 1 horse, 2 cows and followers to one year, and 12 sheep per holding. The neighbouring township of Dalbeg is allowed an extra cow and followers to one year, per holding. Another weaving township in Barvas, South Shawbost, has 1 cow and follower and 8 sheep per one pound sterling of rent and the rent may be anything between 18*s* and £ 2. 4*s*.» The equations of stock are as follows: One cow = ½ horse, or 8 calves, or 8 sheep (somethimes 7 or 5), or 12 hoggs (sheep 6—12 months old), or 16 lambs. WEST HIGHLAND SURVEY, p. 206.

5 and 15 acres (2—6 ha.), 9.6 % between 15 and 30 acres (6—12 ha.), 2.6 % between 30 and 50 acres (12—20 ha.) and 0.9 % more than 50 acres. These figures do not tell the whole truth, because it often happens that several families live on one and the same croft, either in the only »legal» house, or in separate dwellings as cottars. In addition, the cultivable land area forms only a small part of the total area of each croft. Thus, according to the WEST HIGHLAND SURVEY, one finds the following rations of inbye-land to the total area: North Hebrides 1/21, South Hebrides 1/6, and the ratios of tillage to the total area (1947): North Hebrides 1/59 and South Hebrides 1/23. The situation is made even worse by that part of the population which has settled on the common land, the squatters, who naturally also increase the pressure for land. The result is that crofting alone is not able to provide the crofter and his family with a sufficient livelihood, nor does it fully occupy the available labour force. Thus one can say with COLLIER, »The features common to crofts to-day, and they must not be overstressed, are first, the combination of smallholding with employment outside the croft, which often involves regular absences from home on the part of one or more of the members of the family: and secondly, the extent to which the family is the real working and social unit . . . In almost every case, it is a real centre for the loyalty of the members of the family, whether they are living and working there or are domiciled in a strange land sending back remittances and looking forward to the day of return». Only a few crofters own their own land, most of them are tenants, either of private landowners (about 70 % in all »crofting counties») or of the Department of Agriculture which has bought considerable areas (about 20 %). In 1886, the conditions of tenure, which until then had been rather arbitrary and had caused widespread dissatisfaction were the subject of government legislation. The Crofters Act of 1886 gave all crofters security and compensation for improvements, and in the decade following on the act, fair rents were fixed for all holders who applied. In 1911 these laws were made more precise and extended to cover some related sections of the population. The latest revision of these laws came when the new »The Crofters (Scotland) Act, 1955» was passed.

The most far-reaching change however had been brought about in the early nineteenth century when the run-rig division of the inbye-land, which had been prevalent until that time was generally abandoned and instead the land was divided into individual holdings. Run-rig still exists with respect to the cultivated outbye-land, for instance on some of the machairs. (N. Uist: Sollas, S. Uist: Iochdar, Bornish).

The run-rig land is distributed after a double balloting for the arable area at the beginning of each season of cultivation. The first ballot decides in which

order the second ballot will be carried out, the second decides the parts or »rigs» each one is to be allowed to cultivate. There is usually an extensive rotation of the cultivated outbye-land, the township in common deciding which parts shall be cultivated each year and which parts shall be fallowed. Much of the work of cultivation is also done in common.

In spite of these common features crofting shows considerable differences in different regions. Also in the Outer Hebrides one notices regional differences in the size of the crofts, the division of the lands, and the methods of land utilization. It is the main purpose of this study to illustrate some of these regional differences. On the whole the western parts of Lewis are characterized by especially small crofts. On the north east side of Lewis the crofts are somewhat bigger and land utilization more intense. This is particularly so around Stornoway. The crofts of North and South Uist are on a much sounder economic basis because their area is usually larger and there is much machair land; here cattle-rearing has developed to considerable extent.

In earlier days there were a number of larger agricultural units: today only a few of these are left. Around Stornoway there are 7 »farms» most of which have specialized in dairy-farming. In South Harris and North Uist there are a few sheep-farms, which rent one or several islands as grazings.

In general one can, like DARLING (1949) speak of three different kinds of people connected with the crofting. Firstly there are »the weavers of Lewis», whose crofts have become »an encumberance» through »the tyranny of weaving». Secondly there are the fisher-crofters of the east coast, whose situation has been rendered very precarious by the decline in the fishing industry and the poverty of their scanty lands. Thirdly, there are »the people of the machair», whose crofting is mainly oriented on cattle-rearing.

c. The Use of the Land

The area of arable land is inconsiderable: on an average throughout the Outer Hebrides it represents 7 % of the total area. According to the WEST HIGHLAND SURVEY there are 56.491 acres (22.800 ha) of inbye-land in the Outer Hebrides, the ratio of inbye-land to the total area (715.993 acres) being 1 : 12.5. There are 17.211 acres (6.950 ha) of tilled land, the ratio of tilled land to the total being 1 : 41.5. For Lewis these figures are 25.033 acres (10.100 ha) on inbye-land, the ratio of inbye-land to the total (528.165) being 1 : 21, and 8.985 acres (3.600 ha) of tilled land, the ratio in this case being 1 : 59. And for the southern Hebrides, the figures are as follows: 31.458 acres (12.700 ha) of inbye-land, the ratio of inbye-land to the total (187.828 acres) being 1 : 6, and

8.226 acres (3.300 ha) of tilled land, the ratio of tilled land to the total being 1 : 23 (p. 44). HANCE (1952) mentions that the tilled acreage is 3.1 % and the permanent grass 5.6 % of the total agricultural land, where the biggest part (91.3 %) is rough grazing of inferior quality.

The scarcity of arable land has always been an acute problem. The reclamation of new land has not been able to keep pace with the devastation and impoverishment of the old tilled lands and the growth of population. The hopes, expressed by the writers at the end of the 18th. and beginning of the 19th centuries, that the Outer Hebrides should be like the Dutch and Danish islands, which earlier, — like the Hebrides —, had been »barren marshes or blowing sands, but now constitute a large portion of the strength, industry and resources of those countries» (J. MACDONALD 1811) were not fulfilled.

The division of the arable land into inbye- (infield) and outbye-land has already been mentioned in the preceeding chapter. WALKER (J. WALKER 1812, p. 175) gives a description of this:

»The division of a farm into infield and outfield, was the ancient and universal custom in Scotland, and still subsists, not only over all the Highlands, but in most parts of the Kingdom; and yet, every proper plan of agriculture requires that it should be universally abolished.

The infield is, in general, a piece of land that is naturally good. The farm house always stands upon it: and this seems to have determined the situation of all the old farm houses in Scotland. It is usually distributed in three divisions, or kervels, as they are called. Each of them is manured once in three years; and on this it must produce a crop of bere and two crops of oats. These crops are usually of a very middling sort; and by no means equivalent to the manure and labour that is bestowed upon them. Sometimes there is a fourth division, which is suffered to remain lay, or is used for potatoes; but, in general the infield is kept constantly in tillage, and in white crops.

The outfield again, though all arable, is regarded as waste. When the infield or croft land is worth twenty or thirty shillings, the outfield will not be worth above two or three shillings an acre. It never receives any manure, except that small part, which has the cattle folded on it in summer. It yields grass of the poorest quality and when it has remained ley from four to seven years, and is over-run with mosses, it is ploughed for three crops of oats». See also COLLIER 1953, p. 41.

On the Outer Hebrides the outfields are represented by the arable land on the machair. Differing from the statements of WALKER, these lands are used for grain growing, are manured with seaweed and nowadays also with artificial fertilizers.

As was mentioned above, the arable land is split up into a great number of individual holdings which renders its management even more uneconomic. However, there have been a few attempts to reorganize the tillage of the townships' arable land on a co-operative basis. One or more full-time tractor oper-

ators do all the sowing, ploughing and most of the harvesting in the townships of Melbost (Eye Peninsula) and Borve (Harris), while the rest of the working population is occupied elsewhere: from Melbost they commute daily to Stornoway. Depopulation has also meant that a number of crofts have been left unoccupied, and these are usually managed by the neighbours, who get a better return from the land, which often eventually results in better management. For instance, in Lewis the number of crofts is the same as it was some decades ago, but more and more of them, now about one in seven, are without tenants (STORNOWAY GAZETTE 1954, 26/2).

The division of the arable land into infield and outfield has to some degree a counterpart in the division of the fields into two different kinds according to siting, size, soil and management. Firstly there are the ordinary rather large fields; if situated on the inbye-land they are usually narrow strips (20—30 m wide and 100—200 m long) on peaty soil. Infields of this kind usually have covered drains (see Fig. 11) and are tilled by plough. The outfields on the machair are generally bigger, sometimes having long narrow strips, sometimes consisting of more rectangular units. Because of the light soil of the machair no ditches are required, their cultivation must take into account the susceptibility of these soils to wind-erosion, so that it is necessary to fallow them for several years after one or a few years of cultivation.

Secondly there are the »lazy-beds», one of the most unique features in the agrarian landscape of the Outer Hebrides. These fields are usually situated on the inbye-land, but especially in former days, considerable areas of the outbye-land with peaty soil were cultivated in this manner. According to the name lazy-bed, »lea ground is invariably selected» (LEITCH 1910), in the best cases peaty soil with a luxuriant turf[1]. Here ditches are dug at intervals of about 2 m, the soil placed on the top of the ridges, where seaweed has previously been spread. The making and cultivation of the lazy-beds can best be illustrated by the description given by MACDONALD (J. MACDONALD 1811, p. 183):

»5. Ridges. — In peat-mosses or bogs, and on the first turning up of deep waste lands, the Hebridian practice of forming narrow ridges with a ditch on every side, and at each end of the field, is very judicious. — — —

The workman makes a stright furrow with his caschrom[2] — — —. He continues for a hundred yards or perhaps the length of the proposed field. At the distance of from four to six feet from this furrow he draws another in parallel direction. His ditch is commonly

[1] Compare also the dialect word »leaze» meaning pasture, meadow-land.

[2] In earlier days and until the last world war in some »backward» places, the fields and especially the lazy-beds were tilled with an implement restricted almost entirely to the Highlands and Islands of Scotland, the caschrom (i.e. crooked foot or crooked spade), which »probably is the very oldest tool known in these districts. — — —»

two feet broad and from one foot to two feet deep, — — —. Parallel to the former furrows, he draws a second and a third, etc. The whole field is thus ridged into very narrow rectangular parallelograms of perhaps some hundred yards in length, and from four to six feet in breadth, intersected by narrow deep ditches from two to three feet and a half in breadth, and between 12 and 26 inches in depth. Those ditches are exellent drains; and the soil which they contained, being added to the ridges, and intimately mixed with the manure, as well as completely pulverised by being exposed to the air, and being broken by the caschrom and the common spade, yields a capital mould for potatoes.

After a crop of potatoes, for which this species of tillage is observed to answer particularly well, the ridges remain as the persons who have gathered the crop chuse to leave them until the end of April. One coarse and careless ploughing or perhaps merely a harrowing, is then given, and a crop of barley, without any grass seeds, and without any idea of cleaning the ground, is taken. After the barley is cut down, the ridges of which the sides have now fallen into the ditches, and totally intercept the course of the water, remain in a state of absolute neglect, until oats are sown in March or April. Neither the barley nor the oats get any manure. A second crop of oats follows, and a third if the land is remarkably good, until it is left a complete *caput mortum*, with scarcely the vigour of producing any grass, but the most ignoble weeds and thistles. Thus at the conclusion of a series, pretty skilfully and judiciously begun, the poor ridges are found in a dismal state. Distorted, crooked, and serrated, their sides are overgrown with rank weeds, and the ditches, which have received the best soil of the ridges, display a luxuriant growth of sprets (Juncus articulatus) and rushes (J. effusus). During five or six years thereafter, the field must lie dormant, while nature works by her *vis medicatrix* to restore the exhausted and debiliated powers of vegetation to the soil. Nothing worth mentioning is produced. At last a new crop of potatoes is prepared for, in the way already described, and the same practice of making and unmaking the ridges is followed.»

It should be realized that the methods of cultivating the lazy-beds differ in different parts of the Hebrides. Thus the beds in eastern Harris (for instance in Scalpay) are permanently kept in good condition for growth by manuring and frequent tillage. In contrast to this, the lazy-beds of many parts of Lewis and the Uists are really semipermanent fields of cultivation. MacDonald's description of them can still be applied, except that the caschrom has been replaced though perhaps not to any advantage by the spade, and the barley by oats.

»It (the caschrom) is formed of a shaft or handle of oak or ash, about 5 feet 9 inches long, and strong enough to bear the whole power of the labourer's two hands, without bending or breaking, the head of the tool, which is almost at right angles to the shaft consists of a flattened piece of the same wood, sometimes added and fastened by iron hoops to the shaft, and sometimes a continuation of the shaft, when the piece of wood admits of it by its natural curvature. This head is two feet nine or ten inches long, and about four inches broad, and armed with an iron coulter of quadrangular form, for penetrating the ground. There is a strong wooden pin fixed at the junction of the shaft and head on which the labourer's right foot applies the whole power of his body for pushing with two jerks the

head of the caschrom into the ground previously to his turning the clod, which he always does from right to left, walking backward during the operation of turning the successive clods» (J. MacDonald 1811, p. 151).

The STATISTICAL ACCOUNT OF SCOTLAND (Vol. 10, Parish of Harris, p. 342—392) gives the following description of the different stages in the lazy-bed cultivation: 1) Cutting the seaweed for manure [1], each colony (township) being allotted its proportion by ballot. As much as 200 creel-fulls of seaweed was needed to produce one boll of barley. It is said that the crofters had to be good climbers as there were no roads and no horses. 2) Tilling the soil with »the lugged spade» (casdireach) or with the caschrom. 3) Then the bed was left undisturbed for a few weeks, then hoed and finally the potatoes were sown with the help of a dibble. 4) The bed was then lightly harrowed with a hand-rake (6 timber teeth and a handle 2 feet long). 5) Finally it is mentioned that after the first potato crop successive crops of oats were taken. — Several advantages of lazy-bed cultivation were pointed out (p. 248): »this manner of cultivation gathers the ground, rises it from the running water with coks of which the field abound, and which otherwise would sink and destroy the seed». It is however not clear what is meant by »coks».

The peculiar manner of lazy-bed cultivation and the impression of the lazy-beds on the landscape has induced STEVENS (STEVENS 1925) to compare this with oasis-cultivation. Again MACCULLOCH (J. MACCULLOCH 1819) mentioned that »by this almost Chinese system the shallow soils found on the rocky substratum are rendered productive». He thinks, however, that the lazy-bed cultivation has also been applied in those areas where it is not the most suitable method; for instance on deep peat soils, where the same number of ditches, properly laid out, could drain a much wider area than the few lazy-beds do. It is also to be stressed that the frequent ditches reduce the actual productive land to about 2/3 of what is recorded, for example for statistical purposes.

In spite of the fact that the cultivation of lazy-beds has declined sharply on an average to only 1/3 of the previous area under cultivation, they still constitute one of the most conspicuous features of the human landscape of the Outer Hebrides. »The appearance of such a tract is not a little extraordinary, since, from the minuteness of the patches, it resembles a collection of webs of baize or cloth put out to dry. The smallness of these gives them an aspect almost ludicrous; especially when widely separated from each other, as to appear like distinct corn-fields» (J. MACCULLOCH 1824, p. 208).

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[1] WALKER (J. WALKER, 1812, p. 189) also mentions the use of ferns as manure on the lazy-beds.

Successful agricultural management demands a considerable amount of fencing. In the Outer Hebrides this has not been possible because of the scarcity of fencing material, stones being almost the only natural resource available.

The need for proper fencing has been felt for a very long time, and certainly much has been done. The type of land-use and system of tenure however make the work almost endless. The stone-dykes, which now enclose much of the inbye-land especially on Lewis were proposed by MacDonald among others, he writes (J. MacDonald 1811, p. 164):

»The inconveniences endured by the Hebrides from the want of inclosures are so great, that the most spirited proprietors grant very high premiums to such of their tenants as build proper fences on their lands.

The Galloway dyke, a species of inclosure commenced in 1720 in the southern district of Scotland, — — —, is the most advisable for the Western Isles. It is from 5 feet to 5 feet 10 inches high, nearly 3 feet broad at the bottom, and gradually diminishing in breadth as it rises from the ground, till within 18 inces of the top. Then it is usually 16 inches broad; and receives a projecting cope of flat stones, above which a number of loose stones are piled up, sloping like the ridge of a house, affording day-light in the interstices of the stone, and thus terrifying sheep and cattle from any attempt to leap over it.«

The maintenance of these stone dykes is very expensive now and more and more fences of barbed-wire on poles of imported iron or wood are seen. The common grazings of different townships are now divided in this manner and all the new enclosures of inbye-land are made with this kind of fence. The individual holdings are completly enclosed in only a few townships, which results in the standard of agriculture being governed too often by the poorest. See Table 3, p. 53.

Of the crops, oats is the most important (2/3 of the total tilled area according to Hance), then come potatoes (1/6), together occupying 82 % of the tilled area (1946). Oats alone occupies 65 %. On an average the potato occupies 17 % of the tilled area. The proportion of potatoes is slightly higher in Lewis-Harris than in the southern islands.

Oats was the most important breadgrain in the Western Isles until after the first world war. »The species commonly sown in the northern isles, and in the more backward of the southern, is» — says MacDonald (J. MacDonald 1811, p. 209) — »the old Scots grey oat, perhaps the very worst and most unprofitable sort of grain cultivated by any portion of mankind. — — — This grain has not a single good property but one, which results from the very circumstance of its misery itself, *i.e.* it does not easily shake from the husk. Its skin or husk being rough, coarse, and tenacious, and the grain or seed being poor and shrivelled, the storms have not the same power over this

wretched sort of oat which they have over the nobler kinds. Nothing but dire necessity could have induced the Hebridians to cultivate this grain for so many generations.»

During the latter part of the last century this grey oat was replaced by the black or bristlepointed oat, which is still the most commonly cultivated, but now it is only used for feeding the cattle. Of this species (*Avena strigosa*) MacDonald says: »The black oat, often called *Forfarshire* or *Mearns* oat, is sown in cold and exposed situations with much advantage. It is called black, not on account of any blackness in the meal, which is as clear and fine as that of any other kind of oats, but because the husk is dark, and communicates a dismal hue to the field on which it grows.» (J. MacDonald 1811, p. 211).

During this century oats has replaced much of the barley grown in the Outer Hebrides; the most rapid change occured during the early 30's. This has been interpreted by Kampp (Kampp 1939, p. 117—118) as a sign of a change to a damper climate, but it may also depend on the fact that in earlier days both barley and oats were grown partly for bread, but are now only grown for fodder and from this point of view oats surely is the more suitable of the two.

Two kinds of barley are cultivated on the Hebrides: *Hordeum vulgare* (bigg, bere or bear, 4-rowed barley) which is more common than *H. distichum* (2-rowed barley). It is mostly cultivated on the Uists and there occupies about 7 % of the tilled area. It is also cultivated to some extent in northwestern Lewis and around Stornoway. It is found where there is machair land (on the W. coast) or where there is soil of better quality (Stornoway). Earlier it was also used for distilling homemade whisky. It was harvested by pulling the straw out by hand, in order to get as long a straw as possible for thatching the houses. In 1946 there were 828 acres under barley, half of this was on the Uists. During the past few decades, the area under barley has been continually decreasing, comp. Table, p. 54.

In contrast to barley, which is generally grown on the machair, the oats was formerly grown mostly on the lazy-beds, but now oats and even rye are replacing the barley on the machair. Rye, perhaps introduced by the Vikings, has been, and is still, too often used »to deal the unhappy field the coup de grace of sterility» (J. MacDonald 1811, p. 196). Mixed grains (oats and rye, oats and ray-grass) or sometimes rye alone have been cultivated to an even greater extent as green-fodder for the cattle. The increase has been especially conspicuous on Lewis-Harris and has been possible at the cost of decreasing the area of barley. The mixed grains occupied about 10 % of the tilled area on the Uists (1946).

About potato cultivation it should be added that it is usually a peatland crop. However, on the west side of Barra (Borve) there were small potato fields laid out in the same manner as the lazy-beds on peatland, but these were in pure shellsand a few hundred yards from the shore on a rather steep slope. In Northton (Harris) and Barvas (Lewis) potatoes were included in the rotation of the ordinary machair fields.

The cultivation of roots (turnips and swedes) is on a very small scale (1—1.5 % of the tilled area) and has been decreasing during the past few decades. It is mostly around Stornoway that these crops occupy a larger part of the arable area and they are used to feed the dairy-cattle.

Although hay as a crop increased very considerably between 1930 and 1940 and still shows an upward trend, its proportion of the total tilled area is still remarkably small, or about 1/3. One would assume that the cultivation of hay would be of major importance in such a maritime area as the Outer Hebrides. However, much of the tilled grassland used to be grazed during the first part of summer, which rendered the hay crop both late and of inferior quality. KAMPP says moreover (1939, p. 117) that people have only now realized that sheep are able to eat hay (»En anden grund til den ringe hømængde er den mærklige idé, befolkningen har haft, at faarene ikke vilde æda hø. Det maa vist siges at vaere karakteristisk for befolkningen, at den først nu har opdaget, at faar kan æda hø»). This is so much more astonishing when winter feeding always has been a difficult problem and still causes losses among the cattle and sheep. This problem is reflected in early writings, e.g. »The cattle of every kind descend from the hills to feed on the sea-ware in winter, and after thus having filled their bellies, they return to the heath to mix that dry substance with grass and heath, to qualify each other.» (THE STATISTICAL ACCOUNT 1790). In the descriptions of MACDONALD (J. MACDONALD 1811, p. 432) it is said that »in winter Hebridian cattle suffer severely from want of green food. They must often have recourse to sea-weeds, heather, sprets, rushes, and other coarse substitutes for provender, which they would not look at if not compelled by imperious necessity» and again on p. 433: »The want of winter-food for their cattle is the greatest disadvantage under which the Hebrides labour; and to remove it ought to be a primeval object with all their farmers. This can be affected by raising green crops, by inclosing lands hitherto common or waste, and especially by reducing the numbers of cattle actually kept to two-thirds of their present number». The development of the numbers of cattle however has been quite contrary to this recommendation.

Finally there are a number of garden plants which occupy about 1 % of the tilled area. The most common are rhubarb and cabbage. One also sometimes

sees small patches of onions, lettuce, carrots and radishes. Black currants are fairly common and strawberries are sometimes grown in sheltered places. What an enterprising mind can do in the way of gardening could be seen in a garden north of Stornoway, where cherry-trees and many different flowers were grown.

The small variety of cropped plants is one of the most astonishing features of Hebridean agriculture. It can partly be explained by the adverse climatic conditions and the restricted markets for these products, but the reluctance to adopt innovations, which is so frequently discernable in the Hebridean character, must also play a part.

The cattle of the Hebrides are of the Highland, Shorthorn or Aberdeen Angus breeds. All these are usually kept as beef cattle. In addition the Ayrshires are becoming more and more numerous, especially in Lewis. However, both the beef and the dairy cattle have shown a downward trend, slightly more pronounced among the beef cattle than among the dairy cattle and certainly more pronounced in the northern Hebrides than in the southern. The right of the individual crofter to keep cattle on the common pasture is decided by the »souming» of the township, which is the maximum number of cattle units (this includes all stock) each croft is entitled to put on the grazing land (comp. p. 40 and Table 3, p. 53). The souming is however very often exceeded by the crofters and especially by the cottars and squatters, who originally did not have any rights on the land. In Lewis there are usually 1—2 cows and 40—60 sheep per croft. Horses were earlier kept in great numbers, but are now of very little significance.

The sheep of the Outer Hebrides are predominately of the Black-face breed. The importance of sheep rearing, and its development and relation to other aspects of crofting has been touched upon in several connections (p. 24, 29, 30). The number of cattle shows a marked seasonal variation as the yearly markets are held partly in May and partly in the autumn.

Other types of husbandry are of limited importance. Most significant among them is poultry keeping, but it is seldom on a big scale and usually only for home consumption. Several attempts to start an eggpacking station in Stornoway met with failure. One is however, working successfully at Lochboisdale (South Uist). The Orkney Islands have set a promising example for the egg exporting industry, but conditions are apparently much more unfavourable in the Hebrides.

To a foreign visitor the absence of pigs in the Outer Hebrides is rather striking. The cause of this is partly the risks connected with sanitation in the congested villages, partly the difficulty of obtaining adequate fodder,

and partly competition from more suitable areas of production. Finally the hard climate does not allow much out-of-door pig-keeping.

Efforts to raise the agricultural production of the Outer Hebrides or at least to maintain it at the same level, have been made in several directions. Firstly there has been agitation for better management of the arable land. MacDonald (J. MacDonald 1811, p. 575) suggested several measures intended to improve the agricultural output of the Hebrides, some of which are still valid today: 1) Ploughing of the fields in autumn instead of in early spring, 2) a proper rotation between roots and cereals, 3) the cultivation of potatoes should be confined only to »waste» lands, 4) the practice of fallowing should be more common, 5) better drainage. Finally he stressed that it is destructive to pull the barley straw by the roots, because it makes the soil susceptible to wind erosion and impoverishes its humus content. To this should be added the suggestions of Darling for planting woods to shelter areas of settlement and cultivation from the wind, better drainage, organized under a general plan for the area of the whole township, and more intensive manuring with artificial fertilizers.

Secondly there have several times been proposals for the reclamation of new land, partly from the peat-bogs, partly from the shallow sea bays. And the skinned lands should be taken into cultivation with the help of heavy bulldozers (Darling 1949, p. 359). Lord Salvesen compares the possibilities of reclaiming the land of the Lewis peat-bogs with what has already been done by Norwegian farmers. He concludes »If a proper policy were adopted I believe that the vast areas of peat in the interior of Lewis could be made the best stock-raising parts of United Kingdom» (Lord Salvesen 1941). The possibilities of reclaiming land from sea bays already pointed out by MacDonald, have been surveyed by Oglivie (1945): the most promising area is the Coll Sand, north of Stornoway; however, nothing has been done so far.

Thirdly there has been the question of maintaining the fertility of the machair, the most valuable of the agricultural lands in the Outer Hebrides. The erosion, caused by a too intense use of the light soils, has apparently been in progress for a long time, this is evident from what MacDonald writes (J. MacDonald 1811, p. 177):

»He (Mr. Macneil) admitted, however, at the same time, that, in many of the level and sandy islands, the plough is too much used, and that fields which under grass would be very valuable, are not only less profitably occupied by white crops, but also occassion great damage and loss to the lands in their vicinity. This is particularly the case in islands and districts liable to sand drift. These ought on no account to be opened up for corn crops, provided they already yield tolerable grass crops, and have got a solid and steady

surface. This temptation to crop them with barley, oats and rye, is indeed frequently powerful, because they are often found near the seashore, and near the manure which seaweeds afford, but the crops themselves are insecure, and the wintry storms leave the stubble land a sandy waste, without grass or shelter, and flowerless, bleached, and bleak as the desert of Arabia.»

Because of wind-erosion, sensitiveness to drought, spread of weeds, low fertility and sea spray J. GRANT and D. KERR propose (STORNOWAY GAZETTE 1956, 27/3, p. 6) a change from the prevailing method of using the machairs for grains and fallow, to improved grazings by fertilizing it with phosphorus and cobalt.

It is not yet certain whether the machair land is, in the long run, most productive as pasture or under cultivation. Because of the seaweed manure used, cultivation will add some fertile elements to these soils, but at the same time it makes the area susceptible to wind erosion which will surely lead to a loss of the most valuable humus content in the topsoil. Nevertheless, use as permanent pasture means on the other hand, as does the whole system of cattle, mutton and wool production, a constant loss for the fields with very little replacement by artificial fertilizers.

Table 3. An overall picture of Hebridean agriculture.

Compiled from West Highland Survey (from tables 30, 32, 33, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50 and 51).

	North Hebrides (Lewis-Harris)	South Hebrides (N-Uist, Benbecula, S-Uist and Barra)	Totals for W.H.[1]
No. of townships	168	117	1.040
Total No. of holdings	4.416	1.990	16.519
Normally occupied by tenants	4.363	1.976	15.654
by owners	53	14	885
Crofter holdings	4.093	1.862	13.732
Crofter holders	4.020	1.776	11.926
Size of holdings: (acres)			
Up to 2 3/4	802	95	2.778
3—4 3/4	1.571	157	4.466
5—6 3/4	1.081	233	2.702
7—8 3/4	451	250	1.489

[1] W.H. = The area of West Highland Survey, which in the main includes the region west of the longitudinal mountain ridge of Drum Albyn, and all the islands west of Cape Wrath. The southern boundary is the Firth of Clyde. See map in W.H.S., p. 17.

	North Hebrides (Lewis-Harris)	South Hebrides (N-Uist, Benbecula, S-Uist and Barra)	Totals for W.H.[1]	
Size of holdings: (acres)				
9—10 3/4	166	216	878	
11—12 3/4	98	163	606	
13—15 3/4	86	197	653	
21—25 3/4	33	142	455	
26—35 3/4	33	146	521	
36—50 3/4	17	89	439	
51—100	13	24	455	
Over 100	2	7	280	
Average acreage of common grazing per holdings: (acres)				
Up to 50	42	69	336	townships
51—100	37	19	213	townships
101—200	52	11	192	townships
Over 200	27	8	125	townships
None	10	10	174	townships
Souming (townships)				
Per £ 1 rent	79	13	164	
Per share	3	69	398	
Mixed	86	35	478	
Winter land-use (townships)				
Crofts laid open	137	100	535	
Crofts remain closed, own sheep brought into holding	17	6	186	
Arable let off	—	—	46	
Sheep excluded or absent	12	5	150	
Other uses and mixed	2	6	123	
Cropping acreage, June 1947				
Oats	7.021	4.244	37.303	
Barley	243	419	1.208	
Potatoes	1.947	830	7.865	
Turnips	74	10	5.412	
Other crops	722	3.337	6.625	
Tillage	10.007	8.841	58.412	
Hay	3.440	3.655	42.411	
Grazing	12.333	19.034	116.943	
Inbye-land	25.781	31.530	217.767	
Rough grazing	502.383	156.297	5.426.416	
Total	528.165	187.828	5.644.184	

Changes in acres under crops and the stock of cattle and sheep.

	1911	1921	1931	1941	1947
Barley, North Hebrid. ...	2.833	2.858	1.609	550	243
» South Hebrid. ...	3.666	2.948	1.549	641	419
» total W.H.....	8.203	7.260	3.853	1.869	1.207
Oats, North Hebr.	3.799	4.394	7.529	7.586	7.021
» South Hebr.	3.461	4.052	5.260	5.084	4.244
» total W.H.	41.609	40.988	39.571	41.206	37.303
Potatoes, North H.	3.673	3.706	3.639	2.557	1.947
» South H.	2.202	1.990	1.443	813	830
» total W.H. ...	13.581	12.844	10.553	8.451	7.865
Turnips & swedes, N.H....	184	161	515	132	73
» » S. H....	591	91	93	19	10
» » W.H. .	9.994	8.596	7.663	6.005	5.412
Hay, North Hebr.	624	589	1.752	3.700	3.440
» South Hebr.	903	1.508	3.048	3.272	3.655
» total W.H.....	40.384	43.735	47.476	46.558	42.411
Total livestock in Thousands of Sheep-units					
North Hebrides	171	160	165	172	219
South Hebrides	131	123	115	118	133
Total W.H.....	2.092	1.981	1.822	1.729	1.831
Horses, North Hebr.	1.672	1.426	1.305	830	812
» South Hebr.	3.362	3.075	1.871	1.626	1.354
» total W.H.....	15.970	15.245	10.765	9.517	8.070
Dairy cows and heifers					
North Hebrides	7.599	7.696	7.538	6.003	5.754
South Hebrides	4.764	4.684	4.450	3.571	3.647
Total W.H.....	47.805	46.750	43.154	35.946	35.477
Other cattle[1], N.H.....	7.382	6.010	3.519	2.935	2.499
» » S. H.....	7.725	6.751	5.892	6.826	7.393
» » W.H.	66.916	61.175	49.833	56.961	69.832
Sheep, North Hebrid. ...	78.179	71.992	88.994	112.257	163.513
» South Hebrid. ...	43.507	41.804	46.965	54.727	68.664
» total W.H.	1.373.220	1.303.118	1.239.644	1.183.500	1.249.174

[1] Mostly beef cattle

	1911	1921	1931	1941	1947
Sheep/cattle ratios					
North Hebrides	5	5	8	13	20
South Hebrides	3	4	5	5	6
Total West Highlands ...	12	12	13	13	12

d. The Contribution from the Sea

As a natural result of their insular nature the Outer Hebrides have always depended greatly on the sea for a livelihood. Since the very beginning the sea has been used on a small scale to provide food for home consumption. The scarcity of sheltered harbours and lack of capital have placed a severe handicap on this type of fishing (comp. p. 36). Line-fishing for white fish was most common, and the collecting of edible shellfish (mostly cockles, *Cardium edule*) and seaweeds, both for manure and for food. The low productivity of the land in relation to the population which had to be supported, made this help from the sea and the shore very necessary, thus the STATISTICAL ACCOUNT (1790) remarks (p. 294) that »the production of the country does not serve the people for 9 months of the year, at a yearly average» and of Barra it is said that »sometimes all the islands' 200 families resort on cockles for their subsistence, 100—200 horseloads of cockles being taken every day during May-August». Apart from the fish and shellfish, the collecting of eggs, feathers, down and the hunting of seabirds was of some importance in the past and is still of minor importance in Ness (North Lewis).

The utilization of lake and river fish, as well as of wild fowl by the islanders themselves, has always been very restricted because the game rights are in the hands of the landlords. The rivers are well stocked with salmon and trout, for instance the Grimesta River in Lewis is said to be the best of all the salmon rivers in Great Britain. The interest in using these rivers for angling has until recently, prevented their use for hydro-electric purposes.

The catching of white fish for sale has also long played a part in the economy of the islands, although it was formerly hampered by the difficulty of obtaining material for boats and the restrictions on the salt trade. When the herring fishing was first developed on a large scale in the later nineteenth century, fishing attained major importance as a secondary occupation for the Hebridean crofters.

The Minch herring has two advantages compared with herring from other fishing grounds, especially the east coast herring. It is larger and of better quality and the fishing season in the Minch is longer than elsewhere. There are in fact two seasons, the winter season from early January to March and

the summer season from late April to September. The heyday of the Hebridean herring fishing came at the beginning of this century and lasted until the first world war, then it reached a short lived climax in the mid 20'ties under the influence of Lord Leverhulme and another during the last war. But on the whole the trend has been downward since the beginning of this century.

There are two main reasons for this pattern in the history of herring fishing. Firstly the Hebridean herring was usually cured and exported to Russia, the Baltic countries and Germany. But these markets have gradually fallen off. The Outer Hebrides are in a rather unfavourable situation with regard to the home market. The demand here is mostly for fresh fish and the distances from the Outer Hebrides to the consumer are such that the Hebridean ports are not able to compete with mainland ports such as Ullapool, Mallaig and Gairloch. It was only during the last war that fresh herring from Stornoway reached the home market by special transports subsidized by the government. As well as being sold fresh and cured, the herring is also sold smoked as kippers and Stornoway has a good reputation in this trade, even in the U.S.A. But here too, distances and marketing problems have obstructed development on a larger scale. Four kippering yards are working in Stornoway. Including the curers, the shore personnel employed in this industry amounts to no more than 100. The building of a quick-freezing plant in Stornoway has not altered this downward trend.

Secondly, fishing in the Outer Hebrides has been hampered by the conservatism of the fishermen, and their reluctance to take on fishing as a full time job. Thus most of the Hebridean herring is caught with drift-nets and there are only a few of the more efficient ring-nets in use. Some old fashioned steam-vessels are still employed, they were originally bought second hand. The turn over of the crews has always been rapid, because those employed are usually looking for something better, and only a few younger men and women want to take up fishing or curing work, so that it has been necessary to import labourers from the mainland for the curing season.

The actual situation has apparently changed considerably since HANCE wrote his study on the Hebridean fishing (HANCE 1953). He then considered fishing to be the next important occupation after the tweed industry in Lewis-Harris. Fishing is certainly much less important now than in 1953 when about 1.750 fishermen were employed in the Stornoway district, with 523 vessels in all. Now only about a dozen larger boats work from Stornoway. In Harris the industry has retained importance to a somewhat greater extent, Tarbert and Scalpay being the most important centres. The contrast between the depression period of today and the boom of the time before the last war is

remarkable, then Stornoway had a population of about 3.700, and was invaded by curers and fishermen so that the population rose to about 7.000 (KAMPP 1939, p. 130) during the fishing season. The sight of Stornoway harbour early in May 1956 casts some light on the present situation. A Swedish and Norwegian fleet of modern vessels fishing for ling with ring-nets sheltered in the harbour beside a couple of old fashioned Stornoway steamdrifters, without definite plans for the fishing season which had already begun. The fishing in Broad Bay NE of Stornoway and west of the Eye Peninsula is the most active in-shore fishery left in Lewis, and continues throughout the year, despite the lack of piers or harbours; but it is still very limited in size and occupies perhaps 20—40 men (C. J. HARLEY).

Except the herring some white fish is still caught, but sold only in the local market. About 70 years ago a considerable amount (200 tons per year) of white fish was dried as »klippfish». KAMPP takes the decline in this trade as a sign of a change towards a more humid climate (KAMPP 1939, p. 117).

Earlier, it had been common for the Hebridean women to take seasonal employment as curers in the east coast ports, likewise some of the men were employed as crews on boats from other fishing ports outside the Hebrides. Now this practice is also dying out because they prefer to get permanent jobs.

Finally there is lobster fishing, which has a long tradition but has shown marked fluctuations. It had a period of decline in the pre-war period, but has since attained greater importance. Stornoway, Great Bernera, Scalpay, Lochboisdale and Castlebay are the chief centres. It is well suited to Hebridean conditions because it does not demand heavy capital, but on the other hand it is hampered by the stormy weather. A further development depends on the improvement of external transport facilities.

Among the products of the sea, the seaweed is still to be mentioned; it is processed at Lochmaddy and Orosay (South Uist), see p. 77.

Since olden times the Hebrideans have also been accustomed to take work as Merchant Navy crews, and this still continues. About 12 % of the male population of Stornoway is employed in marine and air traffic; about the same proportion as is usual elsewhere. Most often they take unskilled work, but since the beginning of the autumn of 1953 there has been a school of seamanship and navigation in Lewis Castle which helps to give them better opportunities for advancement.

e. The Integration of the Elements

As has already been remarked upon, crofting provides only a part of the crofter's livelihood. Those tasks which are connected with the care of the croft

are spread out over the whole year and only occasionally demand the concentration of the efforts of the whole family. Subsidiary occupations of different kinds, the economic value of which is often greater than of what the croft can produce, or periods of idleness fill up the time between the main working-seasons on the croft. This yearly rhythm has been studied by some authors, for instance A. GEDDES, who shows it diagrammatically (GEDDES 1936, p. 306 and the same diagram 1955, p. 71). Now this rhythm has been broken to some extent, partly because of the declining importance (or disappearance) of the fishing, and partly because temporary employment on the mainland has changed to permanent jobs outside the Hebrides. In Lewis the weaving of tweed gives a good and convenient way of profitably filling up the idle periods on the croft. In the summer of 1956 a good weaver could earn up to £ 1 per day. The care of the croft demands three periods of concentrated effort: firstly the ploughing and sowing of the fields at the end of March and beginning of April, secondly the dipping of the sheep and peat-cutting from the middle of May to the middle of June and thirdly the harvest, which lasts from the middle of September (the hay harvest has already taken place in the middle of July) to the end of October. The dried peat is brought home between the middle of July and the middle of August: in earlier days it was carried in creels on the backs of the women, but it is now brought in lorries. The bringing in of the peat is even more dependent on good weather than any other task except the harvest, and in some years may be completely impossible. For this reason everybody tries to have enough peat in store for one year at least. The peat is stored in skilfully made »stacks», the size and tidiness of which have a considerable bearing on the social prestige of the owner. In the Uists, and especially in South Uist a greater specialization has developed, thus a declining number of fisher-crofters are almost solely occupied with lobster-fishing. The cattle-rearing crofts are larger in size than those in Lewis-Harris and give a steadier income and occupation evenly throughout the year. Yet there are also crofters, who, like those in Lewis depend on seasonal work outside their crofts. Here it can be weaving (though the weaving is on a smaller scale than in Lewis, with a mill in South Uist), work at the seaweed-factory at Orosay or Lochmaddy (collecting, transport or preparation of the seaweed), or different kinds of casual labour such as road construction and laying water pipes and building. There are, however, long periods when no work is available to supplement croft income, but between these idle periods the crofter's earnings from occasional work may be quite satisfactory. The strong internal loyalty between the members of a family means that the members employed away from home will help the rest of the family during these difficult periods.

This remarkable elasticity is one of the most outstanding features of the Hebridean crofting-system, but it is at the same time, one of its weakest spots. Crofting is not considered as an end in itself, worth the whole-hearted endeavours of the family, or better still of the whole township, to improve it, even by some apparently obvious and simple means such as fencing, restriction of the pasturage, drainage, manuring and better selection of seeds. Instead the farm work is seen as just a part of the *home* on the croft. Most commonly their aim is to maintain the family croft a place of residence for the older members and to that end, the members of the family are prepared to alter their occupations. At the root of this attitude is a strong affection for the land and place of birth, which can best be illustrated by the old crofter's words »there is no place in the world like Lewis, here you can have a real gentleman's life». The croft and the home-township is, even to day, the place to which, at least in their later years, the people would most like to return. The modern welfare state has of course helped such marginal areas as the Outer Hebrides in many ways. Without this support the losses in population and the decline in the economy of the islands would certainly have been much greater.

III. DESIGNS FOR LIVING

1. STORNOWAY REGION

This district and the neighbouring Eye Peninsula with the example from Portvoller lie on the best agricultural soil in the Outer Hebrides. They are also more sheltered from the westerly gales than is the western side of Lewis. The Stornoway district is close to an urban market and one also finds here the only bigger agricultural units or »farms» in Lewis. The agricultural standard of crofting in this area is nevertheless no higher than that of the less fortunate parts of the island. The cause of this is, that the influx of workers into Stornoway has increased the value of housing in the neighbouring of Stornoway to such a degree that the value of, and thus the interest in crofting have almost disappeared. The subsistence-crofting of earlier days has deteriorated without being replaced by a new interest in cash-crops or the rearing of animals (SURVEY REP. on Stornoway). There is no market-gardening or use of green-houses, though there are a few small private enterprises with gardens growing products for home-consumption, for instance one just north of the town, in Laxdale, which clearly shows that the growing of a variety of vegetables and also some kinds of fruit trees, for instance plums and cherries, would be quite possible. The keeping of dairy cattle, except to produce milk for consumption

at home is not common amongst the crofters partly because the standard of sanitation is felt to be too high for them to afford, but more because the crofters have very little interest and little opportunity owing to the size of their holdings for dairying. Here, more than in the case of market-gardening there is also a lack of capital for the improvement of the farm buildings and equipment. The working and economic units are clearly too small. This can be seen in Melbost (E of Stornoway) where 5 ½ of the crofts are run jointly by 2 men, the rest of their population being occupied in Stornoway or elsewhere. (SURVEY REPORT on Melbost & Branahuie).

There are 12 farms round Stornoway with altogether about 700 acres (280 ha) of their land half of wich is arable. However, of these only a few are using their lands with reasonable efficiency. The Macaulay Research farm, west of the town, which was started to make investigations into and experiments on the agricultural use of peat-land has now ceased its activities, the large, jointly run Tong and Garry farms, which lie north of Stornoway (200 acres), suffer from waterlogged land and have a very low productivity. The same is true of the Carse of Melbost farm, on whose land the aerodrome for Stornoway is situated. The Manor farm, also west of the town, (80 acres) is one of the best run and has specialized in dairy-farming. The farm has 20 milking cows of the Ayrshire breed and the land is cultivated solely for fodder production, which in the summer of 1956 was a follows, 40 acres of oats, 15 acres of rotation-grass (for silage), 3 acres of potatoes, 5 acres of turnips and the rest permanent pasture. This farm and the Goathill farm are the largest commercial milk-producers for Stornoway. The Goathill farm is also 80 acres, but it rents additional land, so that the economic unit has an area of 200 acres. It supports 45 cows, 20 of which are Ayrshires for milk-production, and the rest beef-cattle, 150 sheep, and, as an outstanding example of adaptation to an urban market, 50—60 hens and 20 pigs. The best land here is also used for oats, hay and turnip. The drainage of the land of these farms is a difficult problem, because the necessary improvements would involve considerable investment. Both these and the rest of the farms are at an average poor, because there is not a great deal to choose between them, and all suffer badly from lack of capital investment.

The crofts of this area are rather small, they either have their lands all in one block, or as sometimes happens the houses are separated from the agricultural land. The mapped example from New Valley in the N of Stornoway is typical (Fig. 9). It has 4 acres of inbye-land; it supports one cow and its calf and 20 sheep. In this case the tenant was an old man, living partly on his pension and he could therefore take care of his croft. The garden contained

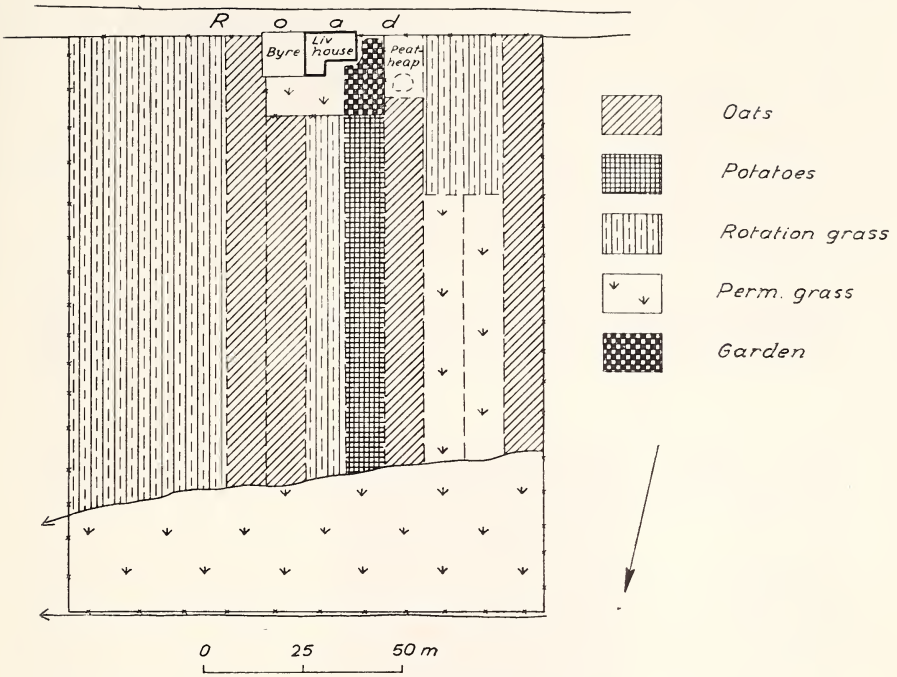


Fig. 9. Croft from New Valley, Stornoway, Lewis, 17. 5. 1956.

cabbage, carrots and black currants. This croft was maintained for the subsistence of the crofter.

2. EYE PENINSULA

The example (Fig. 10) is from Portvoller township. Although the area is situated 10 ½ miles (16 ½ km) from Stornoway the working population commutes daily to Stornoway and most of the crofts are maintained at a low standard. The mapped croft is quite exceptional, being much larger than usual, and having been reclaimed by a successful local entrepreneur about two generations ago. Moreover the family kept a shop, thus they had a considerable amount of time for their croft. Nevertheless the productivity of the croft was mainly on the subsistence-line and much of the land, even that which had been cultivated was in a bad condition, (bad drainage, spread of *Juncus effusus*). The croft had 1 milking cow (Ayrshire X Shorthorn), 2—3 beef-cattle and 20 sheep. The rotation on the fields was: oats / turnip / barley (sometimes + clover) and 3—4 years of grass. Drainage was by a system of covered peat-drains, see Fig. 11, d. The hay was stored in *stacks*; on the farms, larger quantities are stored in big *ricks*, the potatoes were stored in *pits*, see Fig. 11. The garden

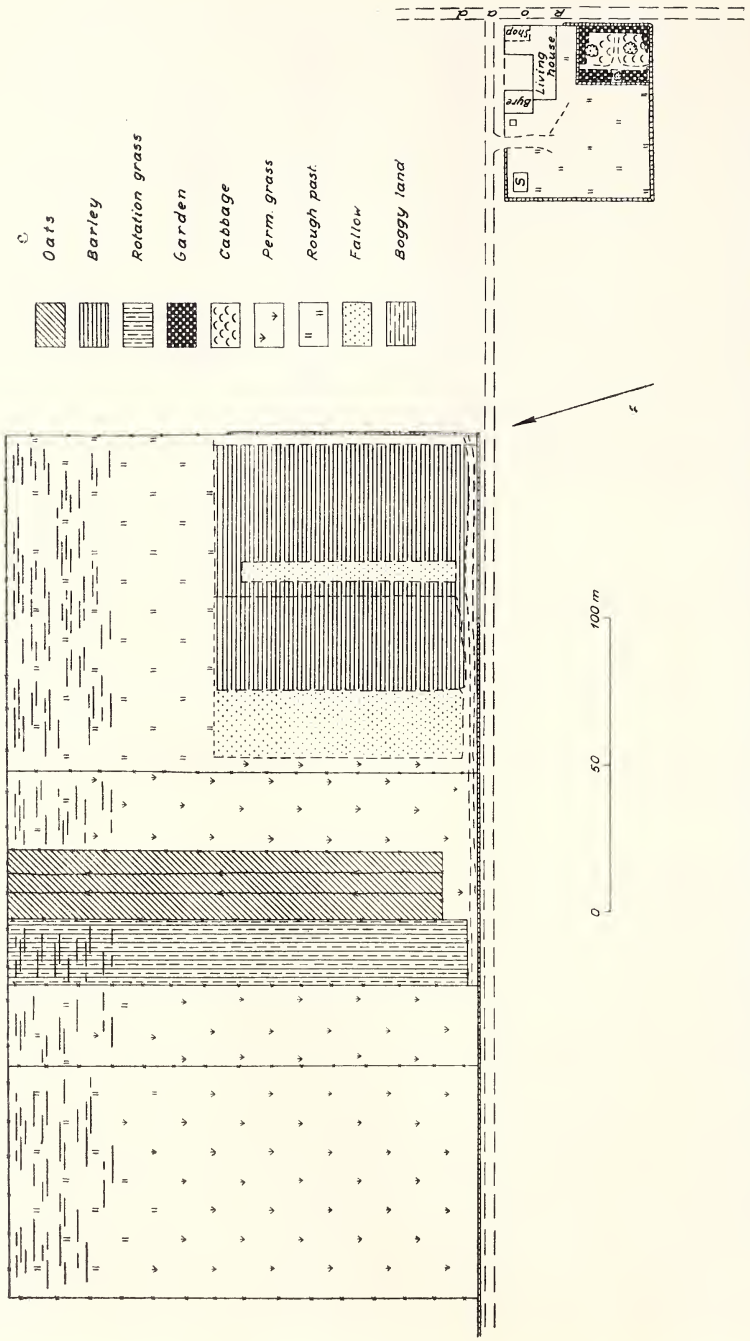


Fig. 10. Croft from Portvoller, Eye-peninsula, Lewis, 16. 5. 1956. S = shed. In the garden two sycamores.

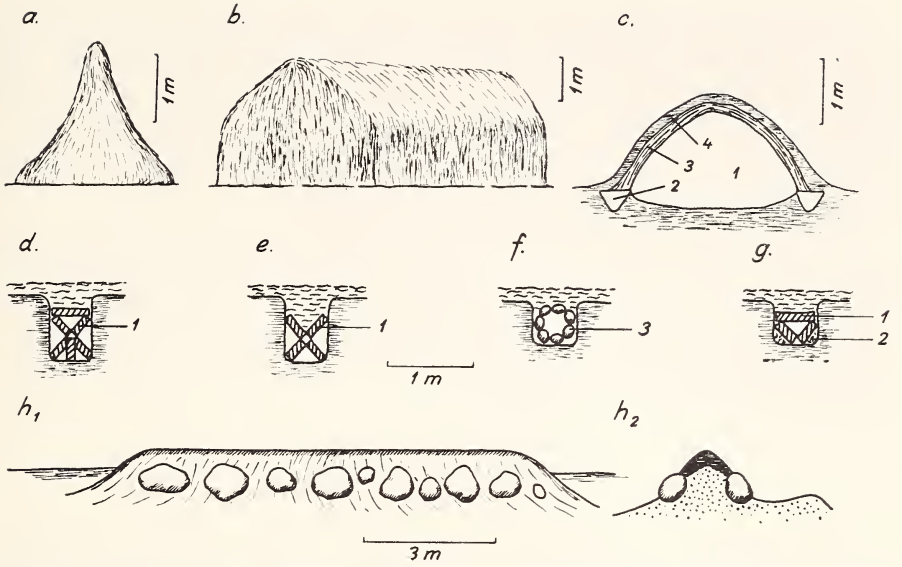


Fig. 11. a) Storage of hay in a stack, b) in a rick. — c) Potato pit, 1 = potatoes, 2 = drains, 3 = straw, 4 = earth (peat). — d-g) Sections of covered drains, d) Portvoller (Eye-Peninsula), e) Arnol (Lewis), f) Barvas (Lewis), g) according to MacDonald (1811), 1 = pieces of peat, 2 = heather, 3 = stones. — h) Ridge erected for drying of *Laminaria*-stalks (Daliburgh, South Uist), h_1 = sideview, h_2 = section, stones on the sides, grassturf on the top.

had a rather large variety of plants; cabbage, early potatoes (sown in February), rhubarb, currants, carrots, some flowers (*Narcissus, Rosa*) and two sycamore trees (*Acer*). The peat was cut nearby, but was of rather poor quality, shallow and brown. The tractor was used for the work of three townships, amounting altogether to 90 acres (30 acres of potatoes and 60 acres of oats).

The first air photograph (Fig. 24) is taken some 5 km north of the town (1940). In the background the high cliff-bound eastern coast of Lewis is visible, in the far distance the high terrain of North Harris can be seen. Then there is the sheltered bay of Stornoway, with planted woods on its western side. The almost triangular town is surrounded by new residential areas, especially in the middle foreground, the factory districts (high chimneys to the east of the town) and the farm-areas, for instance Manor farm, which is the light area north of the wooded area. The relief is very even (Torridonian sandstone) in the foreground and to the left (east). Most of the area in the foreground is peat; notice the eroded white patches, the peat banks where peat is put to dry and the peat roads. One can see the square or rectangular crofts and also that the land utilization is of a rather low standard. The houses are all of the new type. Trees and bushes are rare or absent.

The second air photograph (Fig. 25) gives a closer view of the town, in the background are the same features as on the first photograph. The inner harbour is crowded with fishing vessels because of the wartime boom in the herring fishing. There are new houses in the foreground at Laxdale, north of the town. The 1 or 2 storied houses dominate Stornoway. Farmland at Laxdale almost in the heart of the town is used for sheepwalks.

The third air photograph (Fig. 26), of the neighbourhood east of Stornoway gives a view of the factory areas and the new residential areas east of the town. The suburban township of Sandwick on the other side of the bay has a field pattern, which is in sharp contrast to that found on the lands of the Stoneyfield and Holm farms in the background. The relief here is gentle: one can see the Minch in the background.

3. BARVAS — BRAGAR, ON THE WEST COAST OF LEWIS

The examples from this area are from the townships of Bragar, Arnol and Barvas. They are somewhat differently situated. Barvas lies at the junction of the roads to Stornoway, Ness (North-Lewis) and Carloway (south) and therefore has acquired some of the characteristics of a centrally placed settlement, for instance a high percentage of daily commuters to Stornoway, new Swedish houses for retired Hebrideans and shops. Arnol and Bragar are along the road from Barvas to the south. This area is very much exposed to the westerly gales. The soil is peaty and is exhausted. These are extensive areas of skinned land, the settlement was earlier situated nearer to the shore, but moved farther away, even before the new main road was built (in fact it runs somewhat to the side of Bragar and Arnol). Several of the numerous black houses are still inhabited although there is a considerable amount of building in progress. Electricity and running water have been recently put into most houses. In Arnol and Bragar almost every crofter weaves for the mills in Stornoway; in Barvas weaving is not so common.

Bragar consists of 45 crofts, each with 4—5 acres of inbye-land and altogether 3.900 acres of common pasture. This land is rather flat, rising gently towards Ben Rahacleit (815 feet), Ben Bragar (857) and Ben Choinnich (690). The common area is of very low productivity being mostly occupied by rugged peatlands with very scanty grazing. The only exceptions are the higher and steeper slopes and the narrow valleys of small rivers which sometimes carry a good vegetation cover of sedges (*Carex rostrata*). The winter grazing of this township is very inadequate, providing neither food nor shelter, so that even the sheep are brought on to the inbye-land and they are usually fed on seaweed

for long periods. There are 1—2 cattle per croft, kept only for the sake of the milk they give and the reared calves are of poor quality. Three tractors have replaced the horses, of which there are only 5 left. The cultivated land is situated on the north or seaward side of the long ribbon-like settlement (see air-photo Fig. 28) which, turning north, ends in the small township of Labost. This cultivated land is a sandy peat soil with a multitude of stones and boulders. It has taken the work of centuries to clear small patches of land for lazy-bed cultivation. Numerous deserted lazy-beds cover the lower grounds and bear witness to an earlier more intensive use of the land. The configuration of the coast line, which north of Labost ends in a 100 foot high cliff, has caused a small accumulation of sand in the bay of Port More Bragar. This was formerly cultivated like the machair lands. Now it has been neglected, except a few potato-fields, and partly eroded by the wind. The shielings, some 3—4 miles away from the township were no longer used. There are 2 shops in the township and 3 times a week a butcher's and a baker's van tour this area. The Bank of Scotland also has a mobile office.

The mapped croft (Fig. 12) shows the division of the land of the crofts into many narrow strips. Except for the area of strip 1, the land was unfenced and individual use was thus impossible. The land was surrounded by high dry-stone walls and barbed wire. The lazy-beds were cultivated for potatoes, oats and grass (coxfoot and rye-grass). Inside high circular stone walls, originally erected for growing the willow for creels, early potatoes, rhubarb and some root vegetables were cultivated. The livestock consisted of 40 sheep of the Black-face breed and 2 Ayrshire cows. The crofter owned one of the township's tractors, which was mostly used for drawing home the peat for that croft and its neighbours. The main source of livelihood was the weaving of Harris tweed. The adverse conditions here (exposure, poor, stony soil, division of the croft land and lack of adequate winter pastures) seemed to afford no opportunity for agricultural improvements. The actual land-use is only a relic of the old subsistence-agriculture of bygone days and much of the land is neglected, and exhausted. The drainage is in poor condition; there are almost no ditches round the small cultivated fields.

The township of Arnol is even more crowded than Bragar and there are more inhabited black houses. The division of the land resembles that prevailing in Bragar. The mapped croft (Fig. 13) consisted of two parts, one with a new dwelling house, surrounded by a high stone wall. At the end near the road there were a number of *Sitka* spruces. Early potatoes and cabbage grew on the patches of garden. The men from these townships had been engaged in fishing (line-fishing for cod) before the first world war. The position of the

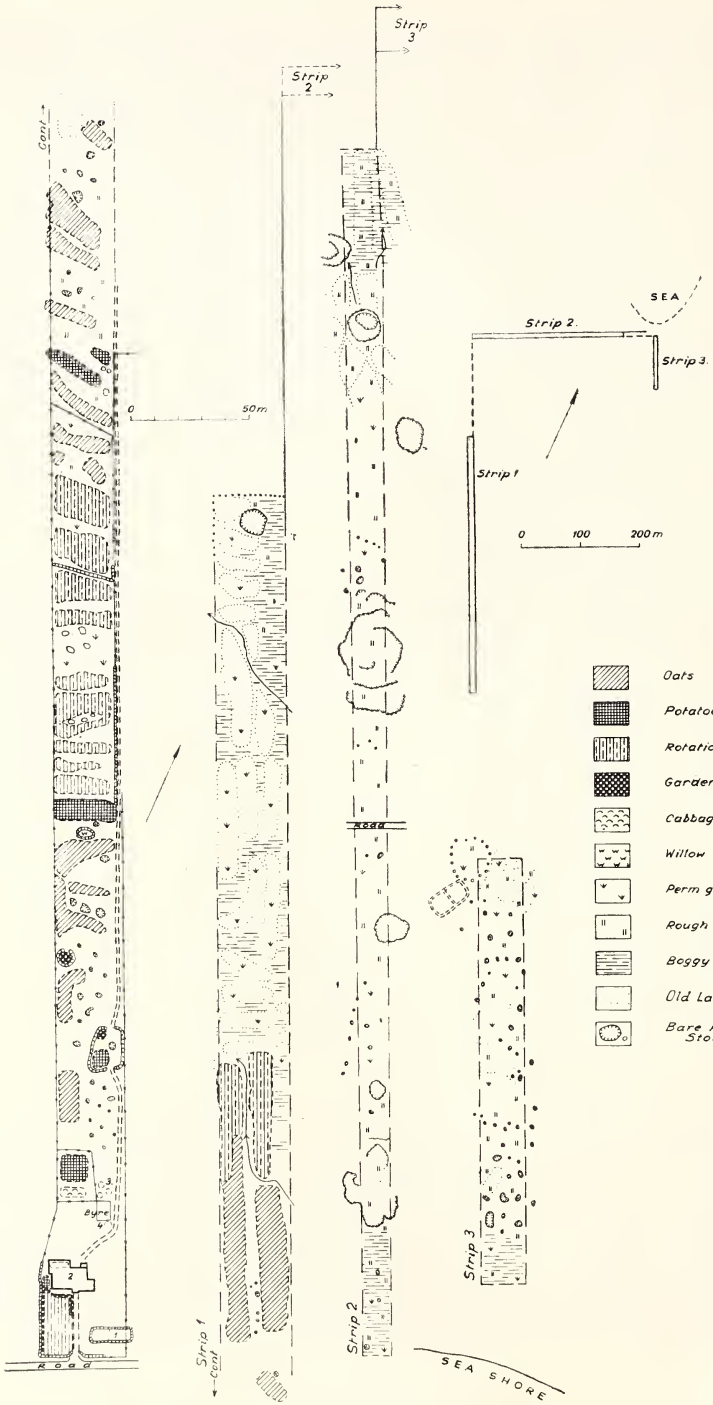


Fig. 12. Croft from Bragar, Lewis, 20. 5. 1956. 1 = Ruins of the old black house, 2 = New living house, 3 = Place for haystacks, 4 = Manure stack.

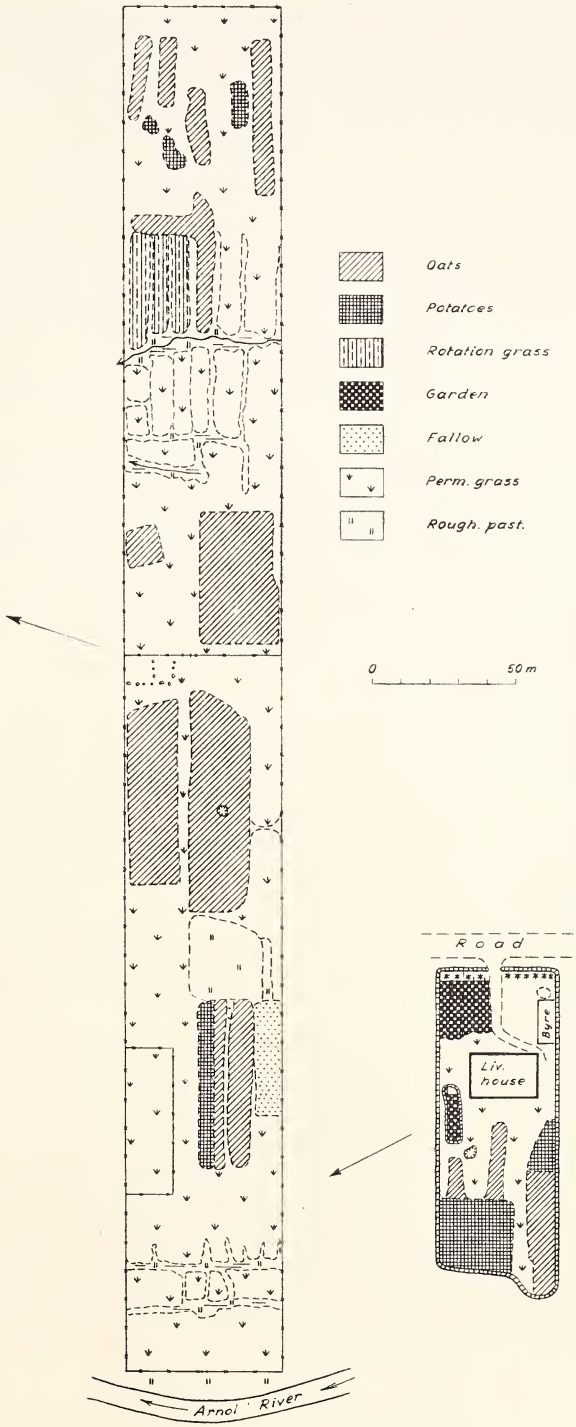


Fig. 13. Croft from Arnol. Lewis, 22. 5. 1956. Along the road is a row of *Sitka* spruce.

fishing-banks was determined by landmarks, now a lost art. Some pigs were kept during the war, but since the price of pork fell it has no longer been profitable. The home-consumption of meat is up to 12 wedders (wethers) per winter. This croft had 2 cows, 55 sheep and 6 acres of inbye land.

The isolated crofts of Fivig (west of '4' on air photograph, Fig. 28) also belong to this area (west of Bragar). One had 5 acres of land, of these 3 were in oats, 1 in potatoes and 1 for green fodder, turnip was grown in the small garden. The livestock consisted of 2 cows and 20 sheep. The other croft had 6 acres of inbye-land, of this 2 were in oats and 2 in potatoes, the rest carried a mixture of several grasses. There were 1 cow and 27 sheep and one horse. No souming was determined. Between November-December and April, 3—4 weeks before lambing at the beginning of April, the sheep were kept on the seashore, mostly feeding on seaweed.

The accompanying photograph (Fig. 28) illustrates this area of Arnol (upper left, only a part of the township being shown), Bragar (the central part), Labost (lower central) and Fivig (lower right). Some features of the relief can be discerned from the photograph. First there is the high, wave sculptured coast line, with its promontories and shallow bays, partly embayed by sand banks. Then the land rises gently towards the line of settlement, on the landward side of which there is again a lower terrain with numerous small lakes. The intricate drainage pattern of the peatlands is clearly visible. The Arnol River (upper left) has a very gentle gradient with only a few small rapids which are just outside the area shown on the photograph. In the upper right-hand corner, between the three lakes there is an example of broken terrain with numerous hillocks rising 20—30 feet above the surrounding surface.

The landscape is completely treeless and not even bushes occur. Much of the area on the landward side of the settlement is »skinned land» carrying a sparse vegetation of grasses, but more usually consisting of the bare remains of the peat. The nearest of the peatbanks still in use can be seen in the uppermost right-hand corner.

The congested nature of the settlement spread out on both sides of the old road is apparent. The narrow strips of land belonging to different crofts are marked by the stone walls which separate these strips for long distances. The black houses can be distinguished from the new houses by their long narrow shape and the rounded outline of the roofs. The road system consists of the new coastal road a little to the landward side of the township, the old township-road, and roads cutting it at right angles, some going to the peatbanks, some to the shore to the old boat moorings. The pattern of both the neglected and used lazy-bed makes a deep impression on the landscape when it is seen from

the air. About two thirds of these small fields are not used any more and even those still in use are not managed in the old fashioned way, but dug with a spade or ploughed with a tractor. The ditches between the beds are almost non-existent or quite shallow. Somewhat better kept lazy-beds can be seen on both sides of the mouth of the Arnol River and in South Bragar just above Labost (4). Generally the lazy-beds run along the slope, as can be seen in the two areas mentioned above, but beds running more or less across the slope are also quite common (comp. the maps). The small round objects are old willow-gardens surrounded by stone walls, the bigger square ones are used as sheep-folds during hard weather in the winter. At the Bay of Bragar (3) a small area of machair of an even grey tone can be seen, with the fields which were previously cultivated in common still visible. In some places there are wind-eroded hollows. The squares east of the Bay are the old and new cemeteries. On a close investigation of the cultivated area between the Bay and the Arnol River one can see a multitude of rather large (1—2 yards) boulders which make cultivation even more difficult.

On the southern and eastern side of the Bay of Port Bragar and west of Loch Arnol, the bay surrounded by sandbanks, at least 6 former sites of settlement can be seen, usually on somewhat higher ground. In the enclosed yards round the houses one can see small white dots which are haystacks and also the darker and less pronounced marks of the peatstacks.

From the township of Barvas, one of the crofts in Lower Barvas was mapped (Fig. 14). This croft was exceptional in that crofting was the main occupation of the tenant, his only additional source of income was a small shop. The soil here is rather favourable: boulder clay underlies the peat mould. The inbye-land of the croft was about 8.6 acres (3.5 ha), of this only 5 acres, however, were under cultivation. Potatoes occupied the greatest part and were grown as a cash crop. Next came hay of excellent quality (clover, coxfoot, timothy and rye-grass) followed by oats. A small field was lying fallow. The old walled enclosure for willow growing was used as garden and the following plants were grown in it: early potatoes, cabbage, carrots, turnips, lettuce, rhubarb, black currants and strawberries. During winter lambs were kept in this enclosure. The livestock consisted of 4 cows (2 Ayrshire, 2 crossbreed), 4 heifers and 40 sheep (and 24 lambs) which were all kept on the common pasture of the township, an area of nearly 10.000 acres, shared by 55 crofts, of which 24 were in Upper Barvas. On the shore side there was a small expanse of true machair-land. On this a patch 70 yards square was cultivated in common by the whole township of Lower Barvas, each crofter having a share measuring 5 × 70 yards. In the summer of 1956 there were cultivated potatoes in it, the next

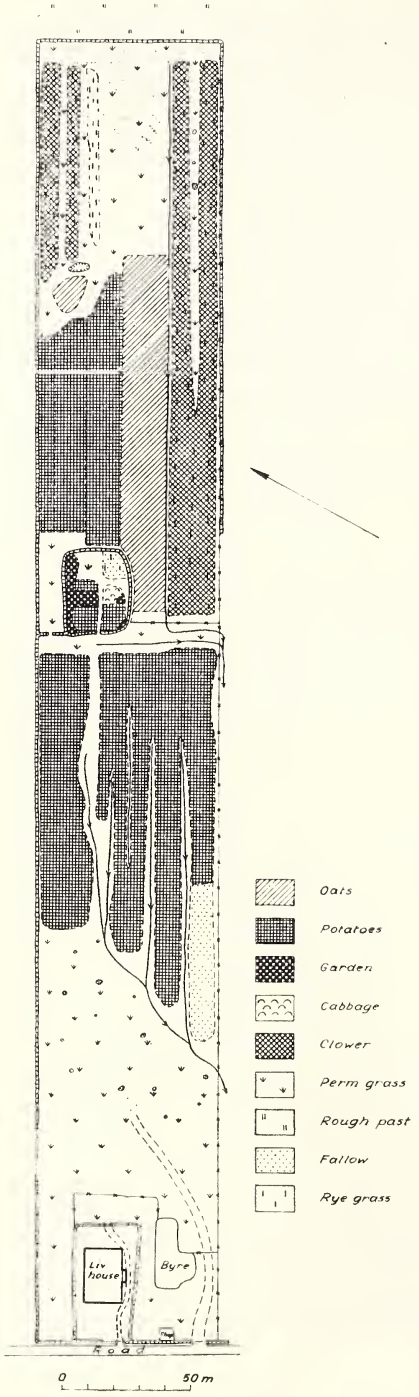


Fig. 14. Croft from Barvas, Lewis, 24. 5. 1956.

crop would be hay and then the plot would be fallowed for 7—8 years. Earlier the machair was manured with seaweed, but this was abandoned and the land was accordingly kept fallow for twice as long as before. The cattle were kept on the machair for one week in August, then in September the lambs were pastured there and when these were finally taken up to the inbye-lands the old sheep were put on the machair for the winter. The cattle were fed indoors from the end of October to the middle of April (nearly 6 months). The peatbanks were situated 4 miles away along the main road to Stornoway. (See also HANCE 1951, p. 79, drainage ditches, see Fig. 11).

4. ARDHASIG, NORTH HARRIS

The next area investigated is from North Harris, the township of Ardhasig (Fig. 15). This township which faces N. is situated on the southern shore of Loch Bun Abhainneadar, a small branch of West Loch Tarbert. Here about 15 crofts lie on poor peaty soil and partly on a steep slope. The mapped croft gives a good impression of the great difficulties involved in obtaining patches of cultivable soil. Here cultivation was on true lazy-beds with ditches 60 cm deep and 50 cm wide between them. They were manured with seaweed. The direction of the lazy-beds is clearly along the slope. The inbye-

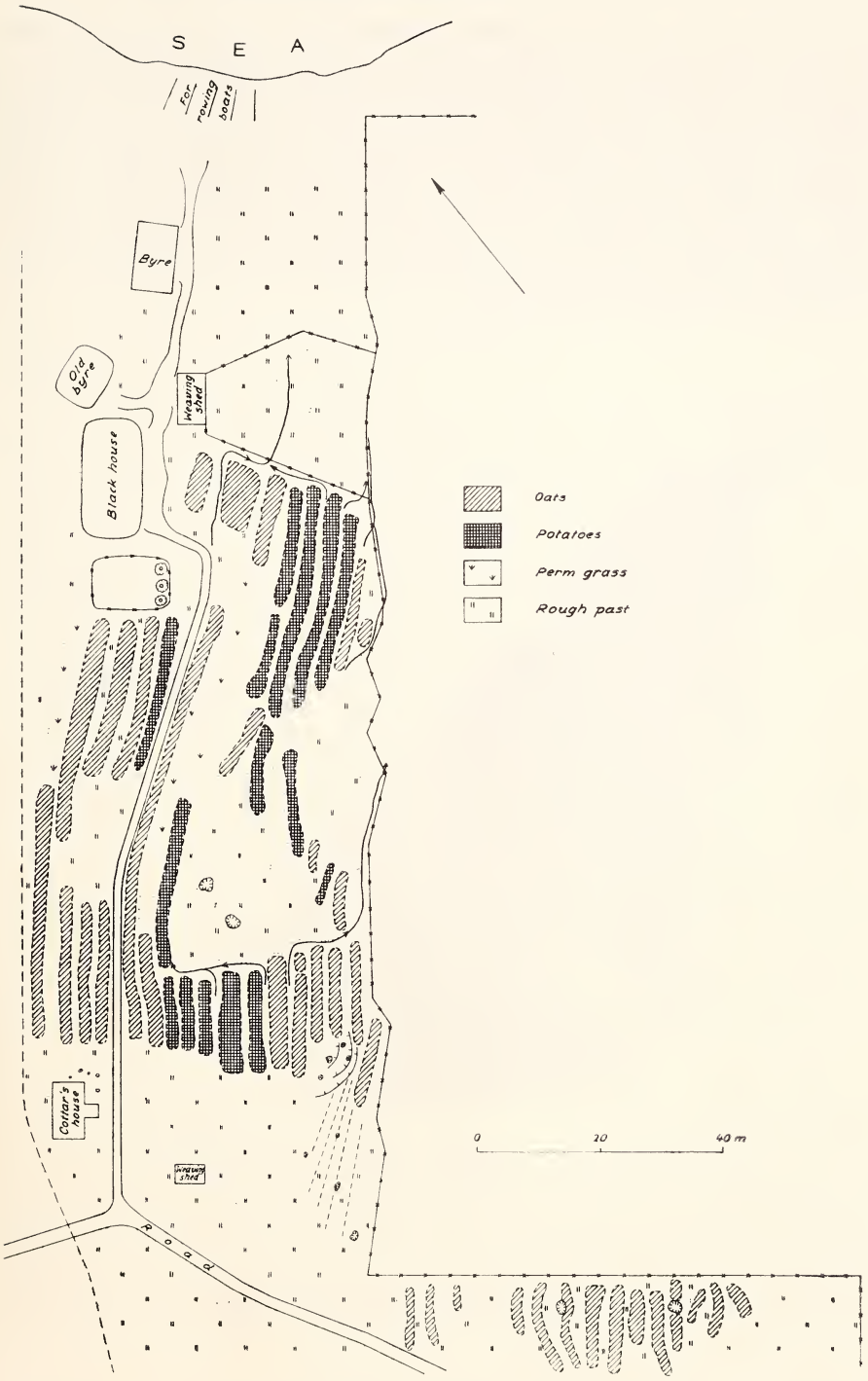


Fig. 15. Croft from Ardhasig, North Harris, 28. 5. 1956. Just belowe the black house is a fenced stack-yard with three sycamores.

land of the croft was not completely fenced off from the neighbouring land and most of the area was rough grazing. As well as the main tenant, there was another who lived in a black house as a cottar; they kept themselves chiefly by weaving. The land was used in about equal parts for potatoes and oats. Traces of the old lazy-beds, now disused, are clearly visible. In the stackyard, fenced off with barbed wire, a few bushes (*Sambucus nigra*) were grown. Except for this there was no garden. The livestock consisted of 2 cows and 180 sheep kept on the common pasture, 1.800 acres in extent. There was some fishing for home-consumption.

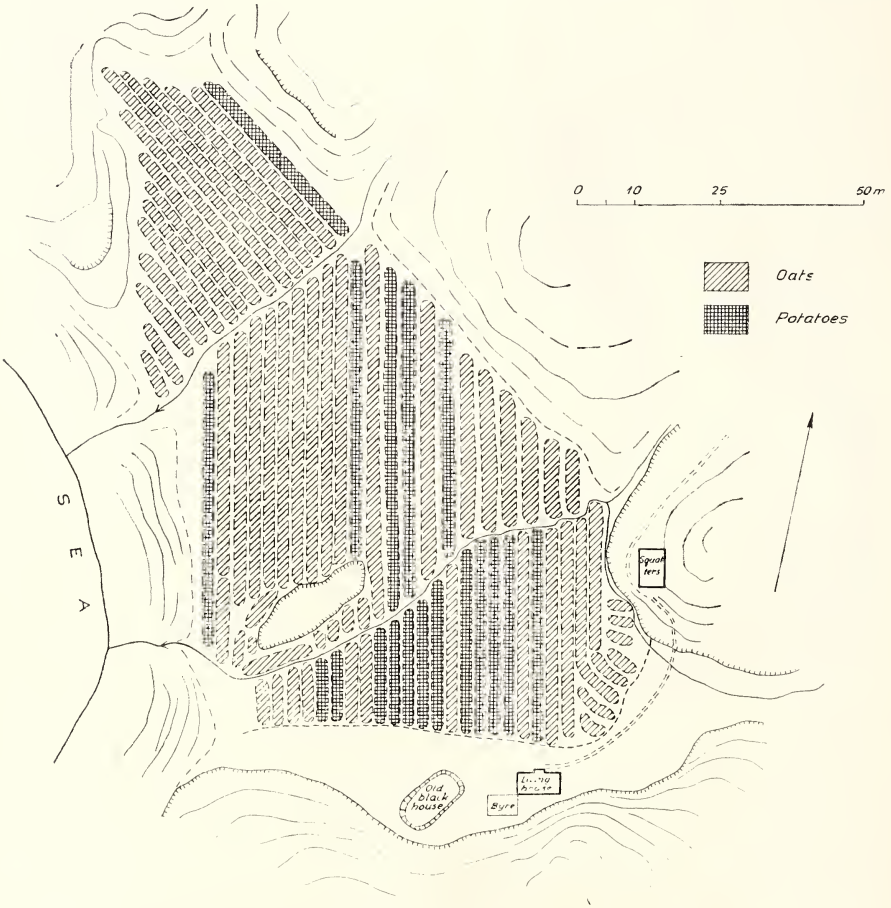


Fig. 16. Croft from Scalpay, Harris, 29. 5. 1956.

5. SCALPAY, HARRIS

The island of Scalpay is famous for its 150 acres of exceptionally beautiful lazy-beds, still cultivated in the old fashioned manner. The air photograph (Fig. 29) gives an illustration of this singular landscape. The ice-scoured surface is rather high, its highest point, Ben Scoravick, not in the picture, is 341 feet. It is greatly broken by valleys, lakes and sealochs. Especially the promontories have been considerably abraded by the sea. On land existing lines of weakness have apparently guided the erosive action of the ice. One can see U-shaped valleys running in several different directions. Most of the surface is bare rock, and peat has only accumulated on the bottoms of the valleys or on terrace-like flats.

The settlement is concentrated on the isthmus between the North and South Harbours, and gives, viewed from the south, an almost urban impression. The school buildings are visible beside the North Harbour, on the western side of which there are also two herring curing stations: one is at the end of the road. Otherwise the settlement clings to slopes of bare rock, thus sparing the few flat patches for cultivation. The same can also be said of the road network. Hardly any black houses were left, some old sites can be discerned on the eastern peninsula in the picture. The island has been an important herring and lobster fishing centre, but even here this industry has declined, though it was still the main source of livelihood apart from crofting. The lazy-beds, built with great skill, fill, in »an almost Chinese manner» every corner of the flat ground and sometimes climb like terraces up the slopes. Nevertheless a considerable part of the lazy-bed area is neglected nowadays, as can also be seen from the picture. The scarcity of peat is such that in many places these old lazy-beds are cut for peat. The peatbanks can be seen as long, narrow and often curved black lines on the photograph. The mapped area (Fig. 16). gives a more detailed impression of the land-use; only potatoes and oats were grown. The area on this map was shared by 4 families. Concerning this area comp. also CAIRD 1951.

6. NORTHTON, HARRIS

The following example is from Northton, southern Harris. This township grew up in the first years of this century when the descendants of the cleared population were resettled on the western side of Harris. It is situated at the neck of the isthmus which connects the Toe Peninsula with the mainland. The 30 crofts divided into 36 shares are on both sides of the straight road and the inbye-lands run at right angles to the road. On the left side of the road

(see airphotograph, Fig. 27) there is a considerable slope, so that, on the mapped croft for instance, the ground rises 10 metres in 200 m:s. On the right of the road the ground was flatter, but also more waterlogged. On the inbye-land good crops of hay and oats were grown (comp. map, Fig. 17), in addition there were some turnips. The garden was well cared for and contained a variety of plants: cabbage, carrots, garden turnip, radishes, lettuce, rhubarb and black currant, and also some ornamental plants: *Rhododendron*, *Veronica* and some rock-plants. The livestock consisted of 2 cows with their calves, 50 sheep and a score of hens. One might notice here a peculiar system of »trans-humance» in connection with these fowl. In summer the flock of hens of each crofter was moved out on to the sea-shore. Here, on the lower parts of the machair, they partly fed themselves. This practice arose because it was impossible to fence off the growing crops. O'Malley (R. O'Malley 1948, p. 94) also mentions this practice: »On the island (Uist) the crofters have solved this problem by moving the hens completely to turf and stone huts on the machair, far removed from all corn during the summer. There it was a more serious matter, because adjacent strips had different owners. It is not easy to love your neighbour when his hens are in your corn.»

On the photograph one can also make out the cultivation pattern dating from the time before the clearances (pre 1816). There are the narrow ridge-like remnants of long and often contorted lazy-beds, climbing in many places to an altitude of 200—300 feet (comp. SE-slope of Chaipaval in the upper part of the picture, and the right side east of the northern bay). It is worth while stressing the different shape, size and structure of the lazy-beds in different parts of the Outer Hebrides.

Between the Toe and the mainland a huge dune has developed in the shelter of some small rocky islands. This dune and the accumulations of sand east of it now form a tombola connecting Toe with the mainland. The bay of Traigh an Taoibh Tuath east of the isthmus is shallow and it is partly dry during the ebb (it extends 3 km outwards). On this dune area the township has machair of almost the same extent as the inbye-lands (comp. photo). It is permanently divided into strips (20 yards broad) running across the dune. Each crofter can cultivate his strip as he likes. The usual manner is to divide it into several parts, each part is then cultivated in a 7—8 year rotation as follows: oats / potatoes / oats / oats + grass (clover) / 4—5 years fallow, (comp. the map, Fig. 17). The lower parts of the strips were boggy and used as pastures for the cattle. On the picture the haystacks can be seen, about 4—8 for each croft (the picture was taken in October). The machair is manured with seaweed, each crofter using 3—4 lorry-loads. This township relied largely on crofting,

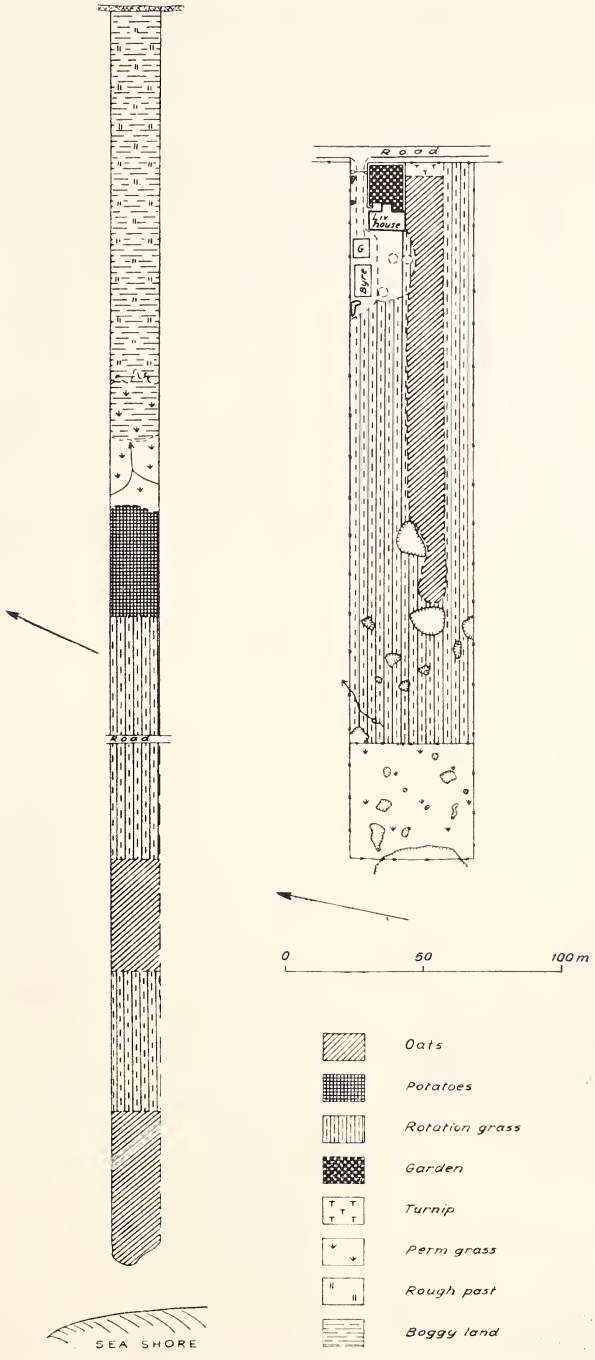


Fig. 17. Croft from Northton, Harris, 31. 5. 1956. G = Garage. The longer and narrower strip is on the machair land.

the only subsidiary occupations were road work and the like, or semi-permanent jobs on the mainland.

7. IOCHDAR, SOUTH UIST

The Uists are represented by three mapped crofts from South Uist. The first one (Fig. 18) is from Garriegannichy, Iochdar on the northernmost part of S-Uist. It is a big cattle-rearing croft consisting of 38 acres of inbye-land (in fact 2 shares) and 2 shares on the machair-land (26 acres). The total of machair is 1.147 acres divided into 88 shares. Oats and rye, often in a mixture, and potatoes were the main crops, both on the inbye-land and the machair. In addition there was a little barley and turnip grown. No hay was grown and the rotation consisted of barley/oats/potatoes and 2—3 years fallow. Also, the inbye-land was on sandy soil. Red and White clover and rye-seed were used for fallowing. No drainage ditches were used. The livestock consisted of 21 cattle, of these 7 were milking cows, the milk being used for butter making. The young cattle, six in number were kept on the machair with the common herd of the

Fig. 18. Croft from Iochdar, South Uist, 3. 6. 1956. 1 = Living house, 2 = shed for horses and impliments, 3 = byre, 4 = for young cattle, 5 = for hens.

whole township. There were also 30 breeding sheep, 2 horses and 60 hens, the eggs being exported through the packing station in Lochboisdale. The sheep were kept on the common grazing, an area of 2.366 acres. The fencing was very inadequate, the horses and cattle being driven away when necessary.

A tweed mill commenced production in Iochdar in 1952. At the time of this investigation it employed approximately 100 weavers, each turning out about 2 lengths of tweed per week. Their weekly earning was about 8 pounds. A guided missile range is being developed in this area.

The other mapped croft from Iochdar (Fig. 19) consisted of 1 ½ shares and specialized also in cattle-rearing. Weaving was the subsidiary occupation here (2 looms). The inbye-land was 18 acres in extent and the croft had 15 acres, cheld individually, on the machair. A tractor was used for the farm-work. The roft had 6 cows, 9 heifers and five calves, mostly of the beef type; there were also 60 ewes. Both these crofts are remarkable in having their inbye-land on the same kind of light soil as that of the machair. These beef-cattle rearing regions have been fortunate in many respects especially because their economy has been stable for long periods. They never have been dependent on fishing to the extent that many places in Lewis have and have accordingly not suffered from the decline of that industry. And moreover no dominating centre of employment, like Stornoway in Lewis, has developed on the southern islands. The growth of Stornoway has created a new system of communications, bringing new life to some regions but leaving other, formerly prosperous areas as lifeless backwaters. Here, the economy, to a much greater extent than in most parts of Lewis, is based on resources of local origin. The best cultivable land runs in a belt some 2—3 miles wide, along the Atlantic coast from North Uist through Benbecula to the south end of South Uist. Thus conditions at least as far as communications are concerned, do not favour the growth of any large settlement. In fact there are two settlements which have attained importance as local centres, one at either end of the belt ,Lochmaddy and Lochboisdale, neither of them on the west coast.

At this point it seems to be appropriate to mention the seaweed industry of South Uist. As well as the larger Orosay factory there is another smaller factory at Lochmaddy[1]. The Orosay factory, 6 km SW of Lochboisdale uses Bladderweed (*Fucus*), *Ascophyllum* and *Laminaria*. *Fucus* and *Ascophyllum* are harvested from shallow bays on the east coast during the spring tides. Each bay is harvested only once in three years. A sickle is used to cut the weed. The floats of seaweed are then tied up with rope and pulled ashore. 100 men

[1] Both belong to the Alginate Industries Ltd.

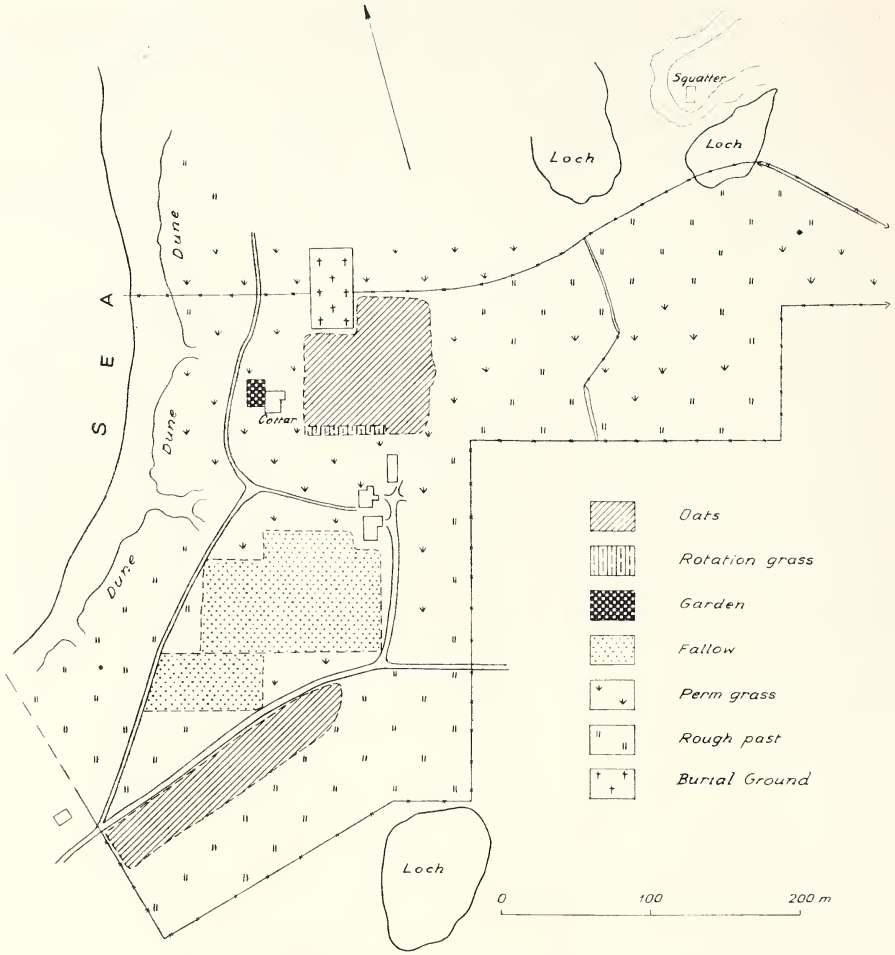


Fig. 19. Croft from Iochdar, South Uist, 2. 6. 1956.

are employed by the factory for the gathering of Fucus and Ascophyllum, which continues the whole year round at spring tides. A couple of lorries transport the seaweed to the factory, where it is dried for 3—4 days (if the weather is good) and finally dried in a kiln and sent to the central factory at Oban which produces the final »acid alginate», a material which has many different uses for instance in textiles, and cosmetics. The factory itself employs about 40 men. Laminaria needs much more hand labour: this big seaweed is cast ashore in April or May on the Atlantic coast. The stalks are separated from the leaf, and the stalks only are put to dry on specially made dykes (see

Fig. 11, h) on the crest of the dunes. About 100 men (crofters) are occasionally employed on this work. Then the stalks are collected after 2 (1—3) months and kiln dryed for 36—40 hours and finally milled and sent to Oban. The best seaweed beds in Scotland are in the Outer Hebrides and this industry still seems to be capable of development (Jackson 1948).

8. DALIBURGH, SOUTH UIST

The crofts in the southern part of South Uist are usually smaller than in the northern parts. There is one example from Daliburgh (comp. map, Fig. 20). This crofter had 14 acres of inbye-land, most of which was on poor boggy land and only the patches shown on the map were cultivated. 4 acres on the common machair a mile away also belongs to the croft. The livestock consisted of 2 cows and 1 calf and 30 ewes. The crofter had been unemployed for more than a year.

This area is also shown on the air photograph (Fig. 30). It shows the two important zones: the machair and the black land with numerous lakes, and the settlement. The gearraidh (piedmont) and monadh (hills) areas are not included in the area of the photograph. The relief in this area is very low and as there are passes or sea lochs penetrating through the neighbouring higher zones, the drainage is usually

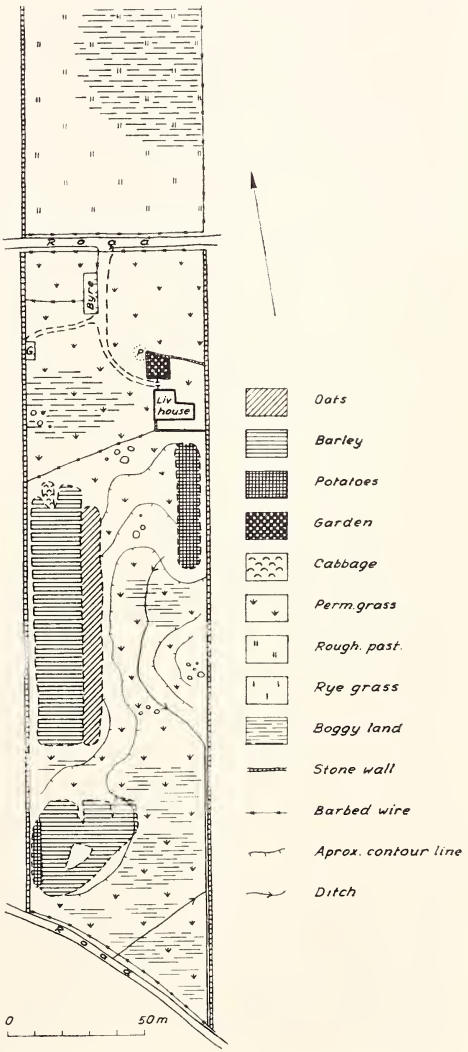


Fig. 20. Croft from Daliburg, South Uist, 5. 6. 1956.

eastward to Lochboisdale. Even the dune embayed lochs are drained to the east. The crest of the dune rises steeply from the beach to a height of 10—15 m, then slopes gently landward. Sometimes there are lower secondary crests 400—500 m inland from the first. Many of the highest dune areas are eroded, it is difficult to decide to what extent over-grazing, rabbits, roads and the digging of sand have been responsible for this and to what extent it is a normal stage in the cycle of dune development.

On the landward side one finds a labyrinth of lakes and low-lying land, partly peat covered or boggy, partly bare rock. These lakes are famous for their bird life; a conspicuous feature was the many swans. The settlement is concentrated in this area and is situated on the highest part of it. Daliburgh has developed into a centre of considerable significance. There is a new hospital and a large school, there are modern shops and the electric power station for this part of the island. The proximity of a good harbour at Lochboisdale has considerably favoured development, but there has been depopulation during the last decades and the sites of several derelict crofts can be seen on the photograph. The houses are mostly new »white» houses or improved »black» houses. The field pattern seems to be much more irregular than for instance in western Lewis. The agricultural land on the machair is individually alotted. There is also much common land on the machair: it is used as pasture for the cattle which are kept in a common herd and watched in turn by the younger men of the township. The method of cultivating the small inbye-fields is usually primitive: there are no ditches and the fields are often tilled by hand. True lazy-beds are seen, but they are not common and in most cases are for a small crop of potatoes. There is a bias towards cattle-rearing here, too. The machair is cultivated individually and the major crops are rye, barley, and oats. These fields are now tilled with tractors, the use of seaweed is still quite extensive, but nevertheless the growing importance of rye as the »best» plant for these machair fields seems to indicate a more and more rapid impoverishment of the soil. Artificial fertilizers have also been used, but the result has been the disappearance of the little humus that was present. The picture is taken in early spring (April 30, 1948) and the white fields are those which were tilled that year, the fallowing lasts for 3—5 years.

The peat resources of much of the settled area in the central part of the picture have been depleted (skinned land), and the peat for the township is now cut in the area shown in the upper part of the picture, the numerous peatbanks can easily be seen as short, usually stright, black strips. The peat here is not very deep. The fences round the inbye-lands are generally stone walls, but these are not of the same height as those of western Lewis, for instance.

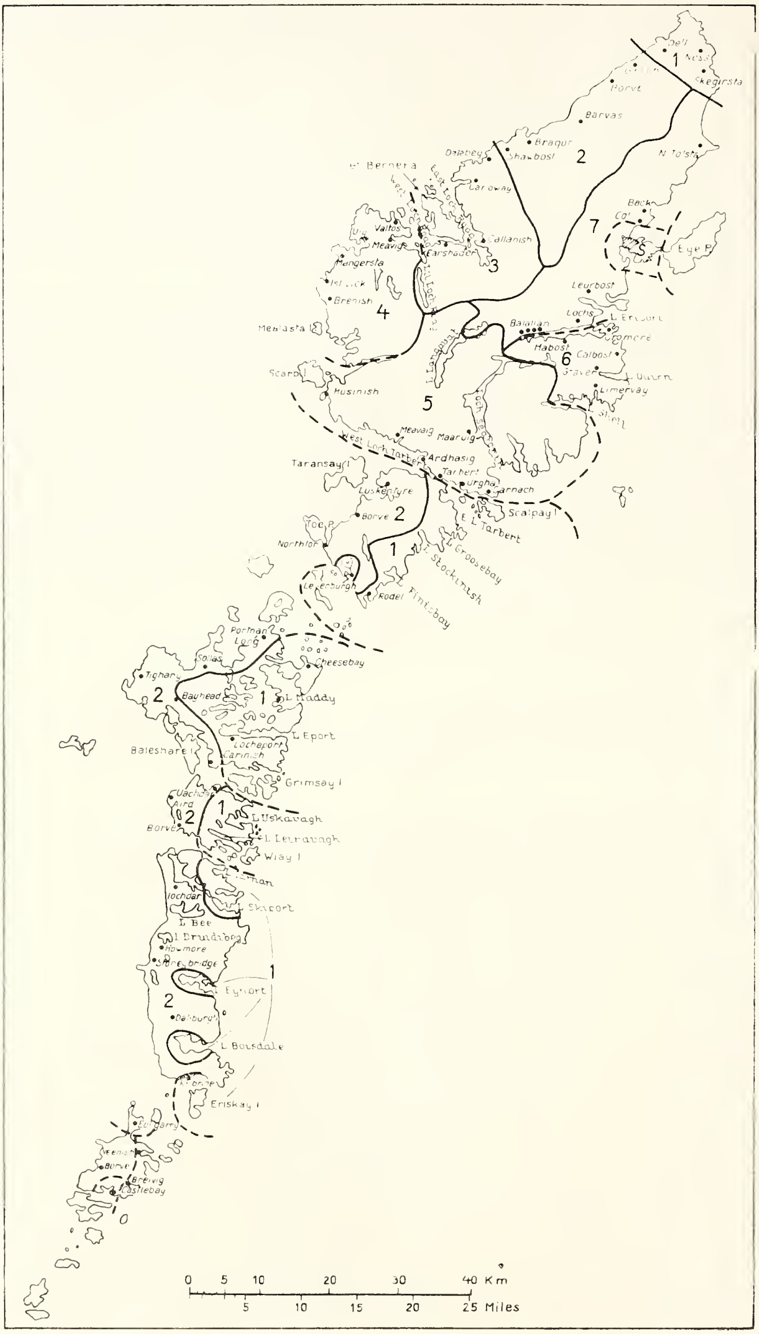
From Kilbride at the S-end of South Uist there is an example of a croft without machair. It had 20 acres of arable land (inbye), all in one plot, including the site of the houses. Of the arable area, $^1/_2$ acre was in potatoes, 1 acre in barley, 5 acres in oats and 2 acres in grass, the rest was under permanent grass of good quality. The drainage was achieved by a series of covered stone ditches. The rotation used was: barley / oats / grass. The livestock consisted of 4 milking cows, 5 beef-cattle and 4 calves, 2 horses and 40 sheep. The 40 hens of the croft produced eggs for sale. This croft was thus in a fairly sound economic condition.

In Kilbride a unique enterprise dating from the days of the big farms was also to be seen, namely the remnants of a glass-covered field. This had consisted of a square (about 100 × 100 m) of high stone walls (2 m), which had been covered by a glass roof to allow the cultivation of vegetables and other garden plants. It is an astonishing thing that nowadays no greenhouses are used in the Outer Hebrides, not even in the neighbourhood of Stornoway. Of course the stormy weather would make their construction more difficult and expensive than in other areas, nevertheless it would certainly be an experiment worth trying.

IV. A SUGGESTED REGIONAL DIVISION OF THE OUTER HEBRIDES

An attempted division of the Outer Hebrides into geographical regions will help to clarify and stress those differences which have been mentioned in the preceding chapters and will provide the background to my final conclusions (see map, Fig. 21). The division into geographical regions will take into account the situation, relief, vegetation and soil, the pattern and appearance of the settlement, and the most important occupations in the different regions. As the author has visited only a part of this comparatively extensive and diversified archipelago, it will be clear that there is considerable reliance on secondary sources. Conclusions can therefore be only approximate.

As was pointed out at the beginning, physically and culturally the Outer Hebrides fall into three parts: Lewis-Harris, the Uists including Benbecula, and Barra Isles. Lewis-Harris is however a »unity» in which there are many contrasts; the main line of division between the different landscapes runs across the southern part of the island of Lewis, somewhat to the north of the administrative boundary which separates »North Harris», which, with the


Ness
Skegirsta
Barvas
Bragar
Shawbost
N. Tolsta
Carloway
Callanish
Earshader
Valtos
Meavig
Mangersta
Brenish
Mealasta I.
Scarp I.
Husinish
Balallan
Habost
Calbost
Leurbost
Lochs
Limervay
Eye P.
Meavaig
Maaruig
West Loch Tarbert
Ardhasig
Tarbert
Urgha
Carnach
Taransay I.
Luskentyre
Borve
Scalpay I.
E. L. Tarbert
Toe P.
Northton
Leverburgh
Rodel
L. Finsbay
L. Stockinish
L. Grosebay
Portnan Long
Sollas
Cheesebay
Tigharry
Bayhead
L. Maddy
L. Eport
Baleshare I.
Locheport
Carinish
Grimsay I.
Uachdar
Aird
Borve
L. Uskavagh
L. Leiravagh
Wiay I.
Iochdar
L. Skiport
L. Bee
L. Druidibeg
Howmore
Stoneybridge
L. Eynort
Daliburgh
L. Boisdale
Eriskay I.
Castlebay
Brevig
Borve
1
2
3
4
5
6
7
0 5 10 20 30 40 Km
5 10 15 20 25 Miles

rest of Harris and the southern islands, belong to the county of Inverness, from Lewis which is part of the county of Ross and Cromarty. As these two parts have often been treated as a whole from the point of view of economy and communications, it seems best to do the same when looking at the area from a geographical point of view.

A. LEWIS

1. In the north is the well defined *region of Ness.* To the west, the boundary between this region and the next runs between the townships of South Dell and North Galson (SURV. REP. on Ness). On the eastern side of the island the southernmost township belonging to the Ness district is Skegirsta, from which it is nearly 10 miles (14 km) along the coast to the next settlement, North Tolsta. This region is characterized by a fairly fertile soil and there are considerable areas of machair on the Atlantic side. The peat here is thinner and less extensive than farther south, and the underlying soil of shelly boulder clay or pure moraine is quite valuable from an agricultural point of view. It is an area of low relief ranging from 50 to 200 feet. The region is rather isolated, as the main road to Stornoway runs via Barvas, a distance of about 26 miles (42 km). The number of daily commuters to Stornoway is accordingly small. The economy of the region is comparatively weak and has not so far been supported to any marked degrees by weaving. Thus the traditional means of livelihood, crofting and fishing, have retained their importance to a much greater extent than in the southern districts. The fishing is carried out by a score of small boats from Port of Ness and two other small harbours, which also lie on the east coast. The catch is sold fresh, mostly within the region, but occasionally in Stornoway. Crofting has not been abandoned, and because of the presence of extensive machair, the keeping of the dairy-cow has been much easier than farher south, where the cattle have to graze on the moorlands. The crofting today is predominately aimed at maintaining the cow and the milk supply of each family. These occupations can only give employment to

Fig. 21. A suggested regional division of the Outer Hebrides. S = Stornoway. The regions are: A) *Lewis:* 1. Ness, 2. the coastal region from North Galson to and including South Shawbost, 3. the coastal region round East Loch Roag, 4. the region of West-Uig, 5. the region of North Harris—Park, 6. the region of South Lochs, 7. the region of Stornoway (divided into 3 sub-regions). B) *Harris:* 1. the Minch-coast (Bays region), 2. the region of the Atlantic coast. C) *North Uist:* 1. the central lowlands and the east coast, 2. the machair region of North Uist. D) *Benbecula:* 1. the lowland and east coast region, 2. the machair region. E) *South Uist:* 1. the eastern fiord region of South Uist (divided in 4 parts), 2. the Atlantic coast region of South Uist. F) *Barra* (divided into 4 subregions).

a small fraction of the population and consequently there has been, and still is wide-spread depopulation. The permanently or semipermanently emigrated population of this district has specialized in the Merchant Service as an occupation. The advantage of having a croft, which can probably support its holder during periods of unemployment and which also provides comparatively cheap housing, weighs less and less against the isolation of this area and the hard unprofitable work which is involved in the maintenance of the original small subsistence croft by the methods practised at present. Sheep-rearing does not play as important a role as it does farther south. In this region some barley is still grown for bread.

2. *The coastal region from North Galson to, and including, South Shawbost.* This region includes three concentrations of settlement, the Borve district in the north, the township of Barvas in the centre, and Arnol-Bragar-Shawbost in the south. They all follow a very similar pattern. The land rises gently from a rocky shore with very little machair behind it, to the area of ribbon settlement which lies 100—150 ft. above the sea. The area of settlement is often on somewhat higher land than the area a little farther inland, and the settled »ridge» is a most conspicuous feature in the landscape of this region. Here the peat cover is almost unbroken, generally even the small cultivated patches lie on peaty soil. The scarcity and exhausted state of the arable land has limited the possibility of maintaining the crofting even at subsistence level, or of keeping a single milking cow, in spite of the fact that the extensive peatlands are used to pasture the cattle as well as the sheep. On the other hand, the unfavourability of local conditions to cultivation has compelled an extension of sheep rearing and especially of the weaving of Harris tweed, which constitutes the main source of income in the area and is supported by a new expanding processing plant at Shawbost. Its position, relatively near Stornoway, which is only 11 miles or 18 kms from Barvas, has encouraged the development of the region. There are also a large number of daily commuters. Depopulation has to some extent been counterbalanced by resettlement by ex-Lewismen. New houses have been built especially in Barvas. In the past, fishing had some local importance, but it has been abandoned; there are no sheltered bays or harbours along this part of the coast at all.

3. The next region is *the coastal area around East Loch Roag;* it includes the township of Dalebeg in the north. Dalebeg, though it is near South Shawbost, lies in a district whose relief is quite different to that of the preceding region. The island of Great Bernera is also included in the region. Its relief

[1] Except at Barvas where there is a considerable area of machair (comp. p. 69).

is very similar to that of the coast of East Loch Roag, and in the field of human geography, too, there is a strong similarity. The »hub» of this region is the township of Carloway, with its sheltered harbour at the end of Loch Carloway. The neighbouring township of Dalemore belongs to the parish of Barvas, which also includes the whole of Ness, while the rest of the region falls in the parish of Uig.

South of Carloway are the townships of Tolstachoelish, Breasclete, Callanish, Garynahine and, south of Great Bernera and separated from the last mentioned townships, Crolovick and Earshader.

The coastline of this region contrasts sharply with that of the areas to the north and to a lesser degree with the coast farther south. The sea penetrates far inland in a rather deep fiord with numerous islands and branching bays. At the heads of the bays there are accumulations of sand, but they are not extensive and seldom continue inland to form true machair. The relief, although low, generally between 50 and 300 ft, is broken by small hills, irregular valleys, short winding streams and a multitude of small lakes. In the area south of Great Bernera higher, ice-rounded hills rise towards the south and »Mountain-Lewis». This area, including its waters is more sheltered from westerly gales than is the coastal region to the north. Thus, it has been possible to find more sheltered sites for settlement than is generally possible in West-Lewis. The settlement is commonly situated nearer the sea — often only half a mile and at an altitude of 50—100 ft. In region '2' the distance often is one mile or more.

The crofting is of the same character as in region '2', although the steeper slopes provide somewhat better drained land. Fishing has long since ceased to be an important subsidiary occupation. In earlier days it was mostly white fish, but now it is the lobster which predominates, and this is in fact one of the best lobster fishing areas of the Outer Hebrides. At the end of the last century a special lobster-pond was built in Great Bernera and now, since it has been repaired, it is used as a store for the lobsters before they are sent by air to London's Billingsgate market. The connections with Stornoway are good, there are roads both from Carloway (16 miles, 26 km)[1] and Callanish (15 miles, 24 km), and this has been an important asset to the weaving industry, which, with the rather prosperous fishing industry has maintained the economic standard at a comparatively high level. Here too, new housing has been built for resettled ex-Lewismen.

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[1] This road was specially built for the old Carloway fishing, and has been little used since then. It is not tarred, and is unfit for all except very strong vehicles (C. J. Harley).

4. *The region of West Uig*, lying north of Loch Resort and west of Little Loch Roag which penetrates south from West Loch Roag, is a well-defined area from many points of view. The relief is in many ways a continuation of that of the preceding region, that is in the north and as far south as the middle of the western side of this region. The northern part is divided up into three promontories separated by sandy bays: Mangersta Sands farthest south, Camus Uig with Uig Sands, Camus na Cliv with Clive Sands and finally the sheltered western end of Loch Roag at Meavig; between these two last mentioned bays there is the wide bay at Berie Sands. The eastern, central and southern part of this region is characterized by rather high mountains; this is especially the case in the south-western district with the high peaks of Mealisval (1.885 ft), Cracaval (1.682 ft), North Liaval (1.625 ft), South Liaval (1.645 ft), Tamanaisval (1.530 ft), Teinnasval (1.626 ft) and Tahaval (1.688 ft) and the intervening U-shaped valleys and corrie-lakes. The eastern part is lower, the separate mountains seldom reaching 1.000 ft in height.

The settlement is split up into small units, which are mostly situated close to the sea at the heads of the bays mentioned above; Carnish, Ardroil, Timsgarry, and Croulista round Uig Sands, Meavig, Uigean and Reef at the end of Loch Roag, and Cliff and Valtos between Cliv and Berie Sands. To the south the settlement avoids the area immediately beside the sea, for instance at Mangersta and even more so at Islivick and Brenish. The region is isolated from the rest of Lewis, the distance from Uig to Stornoway being 35 miles (56 km). In some respects it is a »backward» country, for instance there is a high proportion of old black houses. The region has also suffered severe depopulation. The result of this has been however that this part of Lewis is one of the few, in which a new balance between population and local productivity could again be attained (SURVEY REP. on West Uig). The crofting has also changed over by force of necessity from pure subsistence-crofting to rearing of cashproduce in the form of young (store) cattle and sheep. There is good, sheltered grazing even in winter on the machair or nearby islands (Mealasta, Pabay and Vacsay). The size of the stocks of both cattle and sheep is carefully controlled. There have also been some successful attempts at producing vegetables, soft fruits and eggs for sale. In spite of these energetic attempts the situation is rendered unstable by the large scale emigration which has greatly decreased the number of young people, so that the vitality of these small communities seems to be in danger. The fishing is now of no importance, the only exception here too, is the lobster fishing, which is mostly carried on in co-operation with lobster-fishers from Bernera.

5. *The region of North Harris — Park.* This region is the core of »Mountain

Lewis» beginning in the west with the isle of Scarp and then bordered on the northwest by Loch Resort and on the southwest by West Loch Tarbert; farther east again by East Loch Tarbert, the Sound of Scalpay and the Sound of Shiant. The area is almost cut in two by Loch Seaforth, on the east side of which lies the *Park district* and on the west *North Harris*, including the »Forest of Harris», a shooting moor where deer have been introduced.

Most of the area has a steep fiord coast, the relief of which, in fact is of the same character as in the mountainous area of the interior. This part of Harris has a homogenous relief pattern, with rather high (1.000—2.000 ft) ice-sculptured mountains, and U-shaped valleys in which there are streams and oblong lakes. East of Loch Seaforth the altitudes are lower, reaching at most about 1.500 ft. The »natural» borderline between this and the next region seems to run first along the E-W extension of Loch Seaforth and Loch Skebacleit towards the east and then turning south, runs along the flank of Feirihisval mountain to the western end of Loch Shell. The drainage here follows a more dendritic pattern and the lakes are of a more irregular shape than in the western (Harris) part of this region.

Settlement is confined to a row of small townships along the southwestern coast of West and East Loch Tarbert. The only exceptions are the small townships of Rainigadale, Maaruig and Ardvourlie which lie on the western shore of Loch Seaforth. Except for these the whole region is uninhabited. Beginning in the west the most important settlements are: Scarp on the eastern side of that island, Husinish, Amhuinnsuidhe, Cliasamol, Meavaig, Bunaveneadar, Ardhasig, Tarbert, Oban, Urgha, Carragrich, Kennagary, Steinish and Carnach. All these cling to the steep shore or the mountain sides and some, in the west are situated close to the sea, while others, in the east, are as much as 250 ft above sea level. The possibility of developing a productive agriculture in this region is insignificant. The lazy-beds curve terracelike along the slopes. But the pastures in this better drained area are good, and used mainly for sheep-rearing. The fishing nowadays is only of a very limited local importance, the result being that depopulation, both actual and potential, in form of semi-permanent occupation elsewhere, has been severe in this area. The line of rural settlements is broken by Tarbert, which has developed to a centre of services (shops); it was originally a fishing port (see CAIRD 1951).

6. *The region of South Lochs.* The relief of this small region differs considerably from that of the preceding one, but resembles that in the southern part of the following region (Stornoway). From human point of view, however, it differs considerably from the Stornoway region (SURVEY REP. on South Lochs).

The region is bordered in the north by Loch Erisort, in the south by Loch Shell and tapers out in the east between the flanks of Feirishisval mountain and the ends of Loch Seaforth and Loch Erisort. The relief is very dissected, especially along the deeply embayed cliff coast in the north-east. Generally, except along the uplifted eastern edge it does not exceed 300 ft. There are numerous small lakes and tortuous rivers. The area is divided in two by the line of tectonic weakness which is followed by Loch Ouirn, Kinlochouirn River, Glen Ouirn River, the southern part of Lake Scebacleit and the W-E branch of Loch Seaforth. The area belongs to the parish of Lochs.

This region has almost no assets for agricultural crofting, the broken and rocky terrain, the peaty soil and the absence of machair allowing nothing but the cultivation of tiny lazy-beds, and these only with a great deal of hard work. Thus the people of this region has always turned to the sea, both for fish and for transport. There are four townships situated at the heads of small bays on the north side of Loch Shell, one on Loch Ouirn, two facing the Minch and six along the south side of Loch Erisort. Life in these townships has been rendered precarious by the decline of the fishing industry combined with the distance from Stornoway, which has, by giving direct or indirect employment, saved many other parts of Lewis from economic collapse.[1] Depopulation has been extremely heavy, the SURVEY REP. on South Lochs mention that $^2/_5$ of the population of working age in the villages of Cromore, Marvig, Calbost and Gravir are permanently or temporarily away. The vitality of these villages is very low and it is undermined by the fact that it is mostly among the younger generation that these absentees are recruited. The little agricultural crofting that there was, has declined, the keeping of one cow now being the usual aim of the crofter. Sheep are kept on the large, but nevertheless overstocked moors. The housing situation too, is comparatively bad. A large proportion of the black houses are still in use ($^1/_3$ in the above mentioned villages). The importance of the isolation of the area is illustrated by the fact that some of the emigrants have only moved over to the north side of Loch Erisort in order to be able to commute to Stornoway. The survival of this region depends on the possibility of reviving the fishing industry.

7. *The region of Stornoway.* This region includes the part of the parish of Lochs north of Loch Erisort, the town of Stornoway and its vicinity, the Eye Peninsula and the townships north of the town, Coll, Back and North Tolsta. It can be divided in three sub-regions: North-Lochs, the Eye Peninsula and the

[1] During 1956—57 there has been some introduction of weaving in this area, perhaps 20 men being affected (C. J. HARLEY).

Coll-Tolsta area, as well as the town and its immediate surroundings. The actual dynamic of all these sub-regions is however, closely, and much more closely than any other part of Lewis, connected with the life of Stornoway. There are considerable differences between the physical characteristics of these sub-regions. Thus North Lochs is characterized by a broken terrain, numerous lakes and two penetrating fiords: Loch Grimshader and Loch Leurbost. Conditions are very much the same as on the south side of Loch Erisort, but the decline of the fishing has been compensated by weaving for Stornoway and daily commuting to that town. The Eye Peninsula has very great advantages in its flatness and sandstone bed-rock. The land-use here still follows the old traditions and declining subsistence-crofting is the result, but as some attempts have shown, there would be better prospects of a greater productivity if modern methods were applied. The sub-region north of Stornoway (Coll, Back, Tolsta) belongs to the gently undulating part of North Lewis. The coast is open, without bays of any size and as the coast ends in a cliff there are no machair lands, though sand-accumulations occur along long stretches of the coast (Coll Sands, Gress Sands and Traigh Moor). The absence of harbours has prevented any large scale fishing[1]. The present day economy is predominantly dependent on weaving and work in Stornoway.

B. HARRIS

The island of Harris can, as Caird (1951) has already suggested be divided into two parts: the »Bays», the Minch-coast and the Atlantic coast.

1. *The Minch-coast region*, the »Bays». This region comprises the area east of the high, mountainous area of Harris. The boundary between this and the next region can be said to follow approximately the 300 ft contour, thus the region includes the area south of Tarbert, then the relatively broad east coast area down to the middle of Loch Langavat, and it also includes Loch Finsbay, from which it continues southward as a zone only one mile wide, ending at Rodil. One can include, as exclaves of this region, the islands in East Loch Tarbert, including Scotasay and the inhabited Scalpay, and also the tract round Leverburgh. The region is low-lying, seldom exceeding 150 ft and it is characterized by a highly indented coast with many islands. This region, except for the island of Scalpay, Loch Grosebay and the area round Rodil, was first settled as a result of the clearances between 1820 and 1850. The townships are small and cling to the inner ends of the bays. Of dire necessity, land was taken into cultivation on this rugged and sterile coast, mostly for

[1] Comp. p. 57.

the growing of potatoes. Now only about $^1/_3$ of the old lazy-beds are used for hay, oats and potatoes. The crofts are small, on an average they have only 3 ½ acres of inbye-land. The crofter strives to keep his milking cow and to provide the potatoes for his family. The basis of the economy is sheep-rearing (up to 50—60 sheep per croft), weaving and fishing. In some places here the original »Harris Tweed» is still made by hand. The fishing has also declined here since the boom during the last war and is now mainly for lobster. This lobster-fishing has its centre at Stockinish, where a lobster pond had already been built in 1820. These local industries do not give employment to more than about half the population and heavy emigration, temporary or permanent, is the result. Rodil has some importance as a shopping and communication centre and also has accommodation for tourists. Leverburgh was originally intended to be a herring-fishing centre, but now it is more remarkable for its new housing for retired ex-Harrismen.

2. *The region of the Atlantic Coast.* This region includes the higher parts of Harris, the slopes running down to the Atlantic and the double island of Taransay. The highest parts of this area reach over 1.000 ft and sometimes 1.500. The morphology of the area is governed partly by lines of tectonic weakness predominantly running N-S and the traces left by the scouring of the ice-sheet (SE-NW). Actually the region is divided by lower tracts into 6 or 7 sub-regions: Taransay with Ben Raah, Ben Luskentyre in the north, Clunishval in the centre, Meaval and the barely separate Greaval in the SW, the Toe Peninsula with Chaipaval and finally Roneval in the SE. The coastline consists of wide sandy bays between rocky promontories. The large area of machair and the good mountain pastures are the best natural assets of this region. The crofts are somewhat bigger than in the »Bays», usually about 5 acres and the possibility of rearing cattle makes the crofting more profitable than on the east side of Harris. Weaving for the mill at Tarbert is a subsidiary occupation. However the Harrismen on the whole, are not so much inclined for this kind of »factory» work as the Lewismen and moreover resent the large-scale exploitation of their former home-industry by the Stornoway industrialists.

C. NORTH-UIST

G. L. Davies, in his study of the parish of North Uist (1956) divides it into six morphological regions (1. the mamillated lowland, 2. the glaciated »crags and tails», 3. the central lowland, 4. the glaciated hills, 5. the machair and 6. the drumlin region). Since we are here concentrating on the human geography it will be quite sufficient to divide it into two regions:

1. *The central lowlands and the east coast.* This region does not in fact include the whole of DAVIES' »central lowland» as it seems to be appropriate here to leave out that strip of his central lowland which adjoins the machair in the SW and N and the drumlin region of the SW, and whose utilization is closely connected with those areas. The region also includes the »mamillated lowland» and the glaciated »crags and tails», these »sub-regions» are however completely uninhabited. The inhabited tracts of this region are: a. round Lochmaddy, and in addition the two isolated townships of Hoe Beg and Cheese Bay farthest to the NE, b. round Loch Eport, mostly on its southern shore and c. Grimsay and north of the innermost part of North Ford. The absence of machair compels the population to rely on subsidiary occupations and in this region lobster-fishing is among the most important of these. Another supplementary occupation is the boat building at Grimsay. Loch Eport and Lochmaddy are also important areas for seaweed gathering and a factory was recently opened at Lochmaddy. Weaving too, gives employment to many crofters; a mill is operating in Locheport. The village of Lochmaddy has attained some importance as a centre of communications and services and provides employment for some of the people in this region.

2. *The machair region of North Uist.* This region, although a comparatively narrow zone along the southwest and north coasts accounts for nearly half the population. The region is characterized by »run-rig townships» (DAVIES 1956, p. 75), where the separate crofts have a very small individual holding most of the land consisting of »rigs» in the cultivated fields or »scatts» in the machair. As a result of this the houses of the villages are more clustered than on the east side of the island where the individual holdings are much larger. The crofter here usually aims at cattle raising and wool production. Because depopulation here is still continuing there are many more crofts than crofting families, and each crofter works several crofts. DAVIES mentions as an example the island of Baleshare, where the population in 1901 was 383 persons but where in 1951 there were only 75, some crofters working as many as 8 crofts. Thus a new balance between population and productivity is developing, parallel to the development in the West-Uig area of Lewis (see p. 86). The critical question now is whether the population will be able to maintain its vitality during this change.

D. BENBECULA

This island repeats, more simply the features of North Uist. Most of the land is very low, only at two points does the altitude exceed 300 ft. A similar

division into a lowland region on the east coast and a machair region of the west side can be made.

1. *The lowland and east coast region of Benbecula.* Settlement here consists of the small, scattered and isolated townships round Loch Uskavagh and the area in the neighbourhood of Loch Leiravagh in the SE part of the island, which is somewhat better served by roads.

2. *The machair region of Benbecula.* Here because of comparatively extensive machair lands and a declining population, conditions are well suited to successful cattle rearing.

E. SOUTH UIST

South Uist resembles North Uist, but the more hilly country, and its situation on the eastern side of the island make a difference. The area corresponding to the »lowlands» of North Uist, including the »mamillated lowland», is, on South Uist comparatively small in extent. The high glaciated hills form a backbone lying close to the east coast and running almost unbroken from north to south. The western coastal zone is very wide because of the numerous shallow lakes which lie in the black land zone to the landward side of the machair. Some of these lakes are very large, like Loch Bee and Loch Druidibeg, and are interlaced with the land in an amazing way. Comp. also Fig. 22.

1. *The eastern fiord region of South Uist.* This region is composed of four parts: (a) a northern area round the fiords of Loch Carnan, Loch Sheilavag and Loch Skiport. Here there are small isolated townships, in which the main occupations are lobster-fishing and subsistence crofting. Loch Skiport is the principal fishing centre in this part of South Uist. (b) In central South Uist Loch Eynort penetrates through the mountain barrier and here too there are a few townships facing east. (c) Lochboisdale in the southern part of South Uist is the third sub-division of this region. It gets its special character from the harbour and village of Lochboisdale. But the land utilization and occupations of the inhabitants are essentially the same as in the preceding areas. Finally (d) the southernmost part of this island, including also the densly populated island of Eriskay may be counted as part of this region.

2. *The Atlantic coast of South Uist.* This region runs without a break from north to south and includes both the true machair lands, the lake area and much of the mountainous area in the east. The new road runs along the foot of the hills, whereas the settled lake area lies between this and the belt of continuous machair, thus making the division into the three principal zones easily visible on a map. The economy of this region is principally dependent on the use of the machair either directly as pasture for cattle or for fodder production.

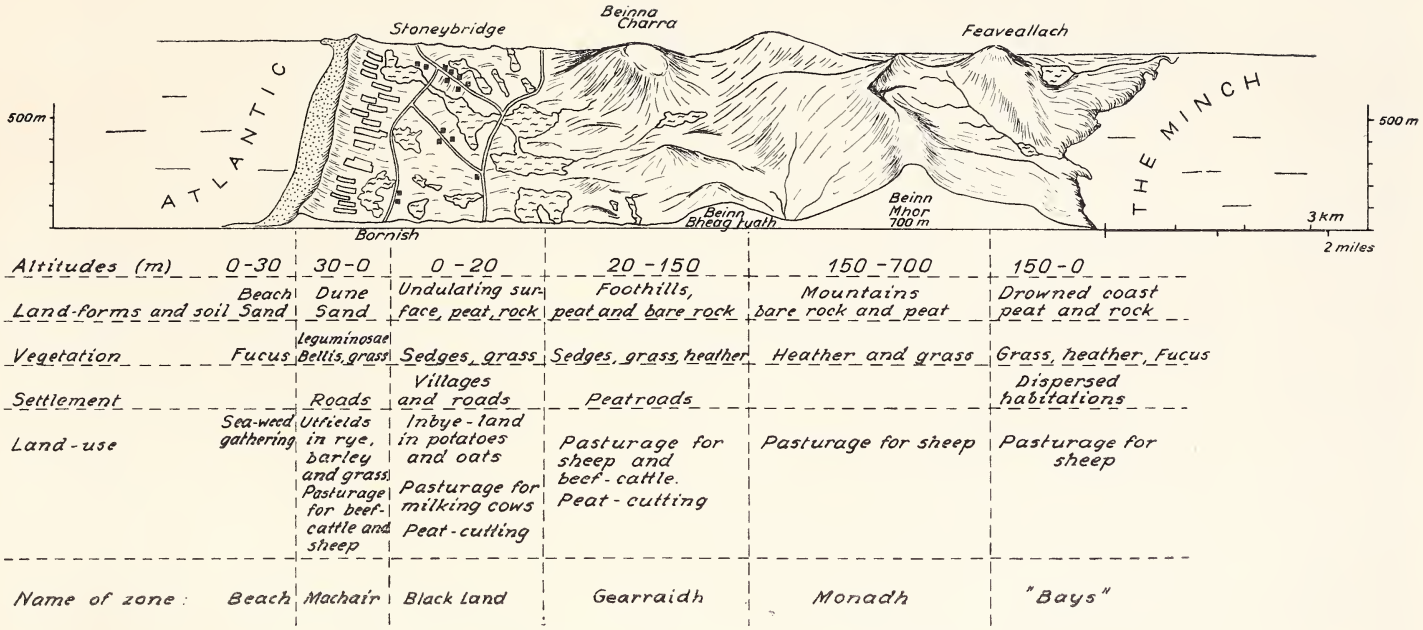

Fig. 22. Simplified section through the southern part of South Uist.

The question of whether the machair land is in the long run most productive as pasture or as cultivated fields is not yet certain. Subsidiary occupations, except for employment outside the area, are of less importance than in the other region. The seaweed-industry is the chief of the secondary sources of income.

F. BARRA

The smallness of this island makes a division into regions inadequate. Nevertheless the island has a varied nature and includes many of the features characterizing the regional divisions of other parts of the Uists.

On the east coast there is an almost continuous zone of settlement adjoining its numerous bays. Here the crofts are smaller (4 acres) than on the west coast, the crofting is aimed at providing subsistence for the only cow and getting some money from the sale of the wool and mutton of the sheep. In the west the presence of machair land and the bigger individual holdings permit the rearing of cattle, which brings in most of the cash income of the croft. Fishing was once prosperous and centred in Castlebay but now it is mainly lobster fishing. The area of Eoligarry is a separate unit with crofts of variable size and more grain cultivation than elsewhere (Hobson, 1949). The smaller islands round Barra apart from Vatersay which is in crofting tenure are mainly used for sheep pastures, a few are also used for cattle. The comparatively favourable climate, the small size of the island and its proximity to Oban have encouraged a more intensive land-use than in many of the other parts of the Outer Hebrides.

V. CONCLUSIONS

A few final points concerning the land-use and population of the Outer Hebrides may be mentioned here.

The subsistence crofting of the Outer Hebrides is essentially of the same character as it was 1.000 years ago, but it is now declining more and more rapidly. The backbone of Hebridean crofting is now the production of milk for home consumption. The system of land tenure, with all crofts being very small and of about the same size, and the difficulty of organizing milk production and distribution in any other way, have preserved the crofting in its old form. The actual land-use, and thus a part of the crofting economy is accordingly on a weak basis. On the other hand it is the only way of maintaining the present distribution of population, which is, in its turn, the heritage of past

centuries. Attempts at introducing rational changes which would lead to higher productivity encounter insurmountable difficulties in the present system of land tenure and partition, and in the capital laid down in housing, which follows the old pattern of distribution, and finally, in an unwillingness to accept any changes.

The decline of subsistence crofting and at the same time of the main subsidiary occupation, fishing, has so far led to only a few serious endeavours at the development of new methods of land utilization based on the production of cash-crops. The commercial production of hay, potatoes and vegetables being the most important trends. The only other local alternatives have been sheep and beef cattle rearing. Besides this, permanent or semi-permanent employment outside the Hebrides (at sea or on the mainland) has been an alternative source of livelihood. The organization of the Harris Tweed industry in Lewis has made a large contribution to maintaining the population, to which it brings the opportunity of industrial income in the crofting townships. Thus a modern livelihood can be obtained despite the decline of the crofting economy and the continuation of the former land-use pattern.

Cattle rearing has long been practised in the areas with sandy machair land, and still plays an important part in the economy of those regions. The development of this industry and the possibility of extending it to the areas with predominantly peaty soils is beset by difficulties in marketing and the selection of suitable breeds for the soft, peaty soils, which can not carry heavy beasts. Cattle rearing is also related to the use of the land for sheep, both from the point of labour and of vegetation. The destructive overstocking of most areas with sheep combined with insufficient care and accordingly heavy losses of sheep, would give this industry too small an economic margin, were it not for the government subsidy. This overstocking also destroys the possibility of better cattle-rearing and a general improvement of the crofting.

The difficulties of crofting are not only connected with the productivity of the crofting lands, but also with population development and the attitude of the population when they compare the opportunities offered by a life in the isolated places of the Outer Hebrides with what the »south» can offer. The younger generation has come to think that the hard work on the croft and its isolated situation in an area suffering from a harsh climate are not sufficiently compensated by the securitys it offers during hard periods or by the relatively cheap housing which may be obtained there. The succession of generations of one family on the crofts is often broken and many crofts have been left without tenants. This leads to a diminished pressure on the land and in turn to better

opportunities for improvement. The critical factor now is whether this change will fatally injure the vitality of the remaining population. As far as the social structure and activities of the present, rather congested rural communities go, there seems, in most places to be a sufficient margin of safety for an additional decrease of the population eventually resulting in a better balance between land and people.

The revival of the fishing industry would involve great capital investment, too great for the local population to bear. This problem must be considered in combination with the problems of the other fishing regions of Britain. The lobster fishing here has many natural advantages and can be carried out without heavy capital investment. Thus it is better suited to conditions in the Outer Hebrides than other kinds of fishing.

The tourist industry would seem to offer a possible source of subsidiary income. But unfortunately the islands lie far from the big concentrations of population, the climate is unreliable and often harsh, accommodation is inadequate and food difficult to buy. This has meant that, in the past, the tourists who visited the Outer Hebrides were either prosperous people who could make their own provisions for their stay and who usually had their own houses during the stalking or salmon fishing season, or people who were cruising. Little attempt has been made so far to attract the average holiday-maker to the Outer Hebrides.

The problems of the Outer Hebrides must naturally also be looked at from the point of view of the whole country. The Hebrides are one of the marginal areas of Britain, their population is small, their productivity is low and is greatly exceeded by consumption and the cost of maintaining a connection with the mainland. But surely the problems of a marginal area such as this cannot be regarded only in material terms. There is also the value of keeping land occupied, not to speak of the feelings of the people. The cost of raising and maintaining a modern standard of living even in this far away area must in the long run be met by an adaptation to new conditions. Thus the recent dispersion of the population may eventually lead to a greater concentration combined with the creation of larger land units and with greater specialization. The existing situation is characterized by the far-reaching change from subsistence crofting to the production of cash crops and cattle-rearing based on bigger economic units than at present. This will inevitably carry with it a redistribution of settlement.

VI. ARCHIPELAGOES IN COMPARISON. THE OUTER HEBRIDES AND THE ÅLAND ISLANDS (SOUTHWESTERN FINLAND)

Already superficially looked upon it seems as if a comparison of such disparate areas as the Outer Hebrides and the Åland Islands[1] would not give conclusions of any validity. The conditions of the physical geography, the situation in relation to neighbouring areas and the cultural development of the populations seem to be of such different values and patterns that no common points concerning the human geography of these areas are likely to be obtained.

Nevertheless, in spite of all these differences, the maritime character of both areas with their widely scattered archipelagoes gives a common frame of such a strength that a number of the phenomena in their nature and a score of the »geographical» problems of their human activity are in fact very alike.

Table 4. Population, Land Area, Population Density, Number of Holdings, Arable Area and Area of Cultivated Grass of the Parishes of the Åland Islands

Parish	Population 31. 12. 1950	Land surface km²	Density per km² land surface	Arable area, hectars	Popul. density per ha arable	Arable area under grass. hectars	Arable area under grass. and % of arable	Number of holdings with less than 2 hectars of arable	Number of holdings with more than 2 hectars of arable
1. Eckerö	942	107.7	8.6	598	1.58	341	57	141	89
2. Hammarland	1.454	127.0	11.4	1.467	0.99	730	50	104	172
3. Finström	2.089	121.8	16.3	1.706	1.22	808	47	220	196
4. Geta	775	81.1	8.9	547	1.42	254	46.5	110	65
5. Saltvik	2.019	143.0	14.0	1.836	1.1	791	43	296	191
6. Sund	1.382	116.5	11.7	1.376	1.01	635	46	152	137
7. Jomala[2]	2.313	144.8	27.4	2.598	0.9	1.319	50.5	347	260
8. Lemland	1.342	107.8	11.5	819	1.68	491	60	77	45
9. Lumparland	448	35.1	12.1	288	1.56	146	51	245	128
10. Vårdö	646	90.1	6.9	404	1.6	215	54	79	49
11. Kumlinge	788	90.7	8.5	338	2.33	186	55	91	76
12. Brändö	927	99.7	8.7	300	3.1	134	45	127	72
13. Föglö	1.188	127.0	9.1	611	1.96	307	50.5	154	98
14. Sottunga	299	25.4	11.1	140	2.15	68	48	40	23
15. Kökar	683	60.5	10.7	141	4.85	78	55.5	130	20
Total Rural Åland	17.317	1.478.2	12.5	13.169	1.27	6.503	50	2.313	1.621

[1] Finnish *Ahvenanmaa*.

[2] Except the suburbs of Mariehamn (1.100), which together with the town proper (3.273) gives an urban population of 4.373. The data are from the 1950 Census.

Thus wind and sea hold the land of both areas in a firm grip, remoulding the relief of the land, causing barrenness in vegetation and demanding ultimately special adaptations from the inhabitants. The insularity creates common features in the pattern of the agricultural land-use of the restricted areas of arable land, it raises in both areas, insurmountable barriers to the large-scale development of communications, industries and other activities, which again causes economic weakness — at least locally —, emigration and depopulation at a time when old established customs and ideals are disintergrating.

The mathematical position of the Åland Islands is illustrated by Fig. 23, which also gives the outlines of the parishes of Åland. The town of Mariehamn

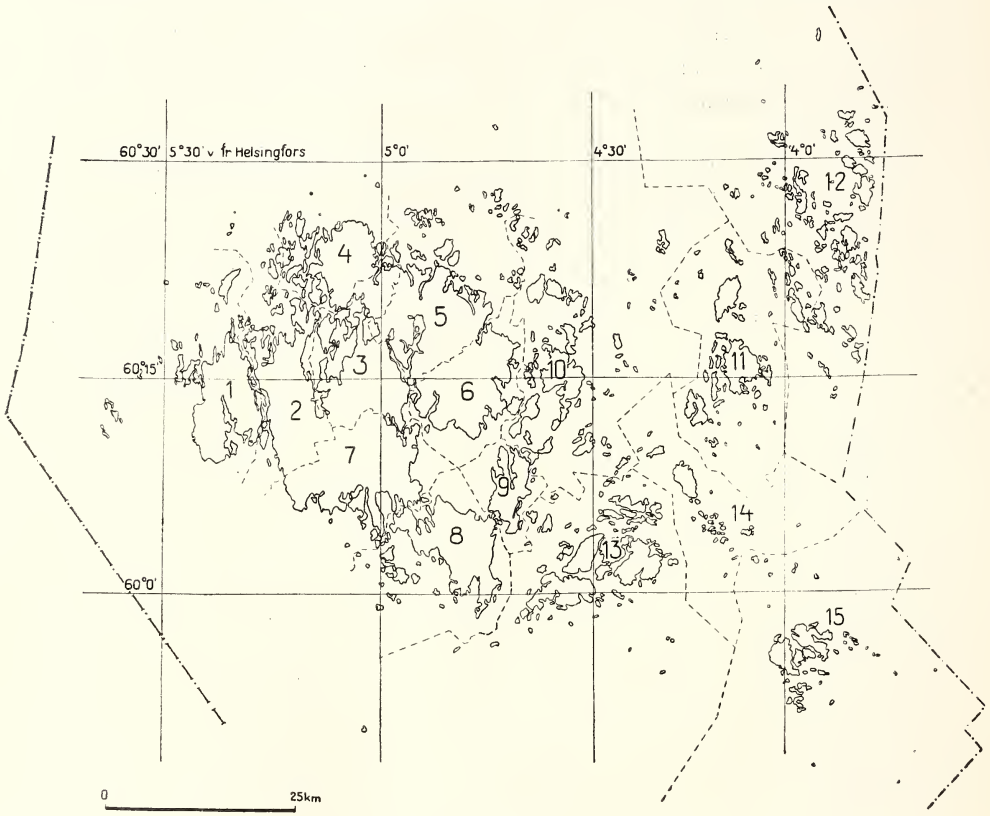

Fig. 23. Parishes of Åland Islands.

1 = Eckerö	6 = Sund	11 = Kumlinge
2 = Hammarland	7 = Jomala	12 = Brändö
3 = Finström	8 = Lemland	13 = Föglö
4 = Geta	9 = Lumparland	14 = Sottunga
5 = Saltvik	10 = Vårdö	15 = Kökar

is situated on the peninsula which extends southward from the middle of the parish of Jomala (7), close to the meridian 5°0′ west of Helsingfors.

There is a fundamental difference between the situation of the Outer Hebrides and that of the Åland Islands. The Outer Hebrides are on Britain's northwestern margin and lie in the open Atlantic. Modern trans-oceanic communications do not use this area as a starting point. From the point of view of natural assets too, the Outer Hebrides are a marginal area. They form one of the northernmost parts of Britain and have one of its worst climates. The Åland Islands although farther north occupy a very favourable situation because of their close proximity to the southwest Finnish mainland, one of the oldest and best cultivated parts of Finland, and in the west, to Stockholm and the highly developed area of central Sweden. The Åland Islands have been situated on the main causeway to Finland since olden times. They have a more favourable climate from the point of view of agriculture than any other part of the country. Thus these islands are not marginal in the same sense as the Outer Hebrides, although there are parts of their maritime borders which are clearly of marginal character. The Åland Islands are half the size of the Outer Hebrides (Tab. 4), and have an almost unbroken contact with the archipelago of Åboland which eventually emerges as the coast near Åbo (Turku). Neither is the distance over the open Sea of Åland to the Swedish coast at Grisslehamn between the archipelagoes of Öregrund and Roslagen very great (25 miles).

Åland is composed of archaean rocks, partly very similar to the gneisses which are predominant in the Outer Hebrides. The mainland of Åland is an immense granite intrusion (»rapakivi granite») in an area of old metamorphosed rocks. Although Åland can also be said to be part of the old pre-Cambrian peneplain of SW-Finland, the extremely broken terrain and the low altitudes give the relief quite a different appearance from that of the Outer Hebrides. This is a result of several distinguishable post-archaean sets of tensional fissures, partly connected with faults, which cross the whole of southwestern Finland. These lines of weakness and the structure of the bedrock, which shows a tendency to cleavage both along horizontal (»banking») and vertical planes made possible the differential action of the Pleistocene ice-sheet. The submergence of the peneplain surface has, in Åland created an archipelago with roughly 6.000 islands usually smaller than those in the Outer Hebrides. The archipelago of the Outer Hebrides is of another size and has had a different geomorphological history from that of Åland. Nevertheless there are some areas which bear a close resemblance to the south-west Finnish archipelago: so for instance the roches moutonnées are characteristic of much of the terrain both on the Åland Islands and the Outer Hebrides, this is apparant especially

along the lower parts of the Minch-coast, as in the region of North Uist which DAVIES has called »the mamillated lowland».

The major features of the relief of the Åland area are governed by the mosaic blocs of the old peneplain, tilted at slightly different angles and altitudes along the sets of tectonic fracture lines. The Peistocene ice-sheet left considerable quantities of debris in this area, and as the land gradually rose from the sea, a rearrangement of the glacial material took place. There are accumulations of stones, gravel, sand and clay, of a considerable extent, quite different from the Outer Hebrides, where glacial deposits, if they are present at all are covered by the peat. The acid type of soil which developes on this land has been considerably improved on the Åland Islands by siluric lime-stone fragments intermingled in the moraine.

Besides the differences in situation and relief there is a marked contrast between the vegetation of the two archipelagoes. It is not only the presence of trees in the Åland area which accounts for the difference, but also the lack of variety and the small number of species, both totally and per area unit, in the Outer Hebrides compared with the Åland archipelago, where a few acres of the decideous forest meadows near the shore may carry several hundred species of vascular plants. However, there are also woodless areas in the Åland archipelago — for instance Kökar facing the Baltic Sea and some parts of Brändö parish again facing the Gulf of Bothnia. Even here low bushy growths of birch and alder are found in all places where soil has accumulated. Treelessness gives rise to differences too, because of the influence on the development of soils, the shelter which they can give and the material which they provide for housing, including roofing, fencing, and fuel. Nevertheless the scarcity of suitable wood from local sources, especially of timber, is one of the characteristics of the truly insular parts of the SW archipelago of Finland.

Much of the arable land on the Åland Islands is situated on glacial and post glacial clay, to a lesser extent on moraine and sand. These soils occur in the lower lying parts of the islands, filling the pockets between the rock outcrops, and they are being exposed continuously as the land rises (50 cm/100 years). In a few places they may cover one or two square miles uninterruptedly but usually they are only of a few hectars in extent. This scattered distribution is one of the outstanding features of the arable area of the Åland Islands.

The population of the Åland Islands is slightly below half that of the Outer Hebrides. Of the 22.000 inhabitants about 4.000 live in the only town in this region, Mariehamn. The population density in the rural districts is somewhat lower than on the Outer Hebrides (comp. Table 4) and there is not the marked

agglomeration characteristic of the Hebridean townships. The number of inhabitants per village is on an average between 70—100 persons, but the villages are more evenly distributed. In the true archipelago, the islands are in many cases small and sometimes inhabited only by 1—5 families. This dispersion and isolation of the inhabitants is in marked contrast to the distribution in the Outer Hebrides. The people of rural Åland are generally employed in agriculture, in local services and in the declining fishing-industry. In spite of the lower population density, the higher productivity of the soil and the generally bigger holdings, there has been a shortage of employment which has resulted in emigration and semi-permanent work outside the area. Depopulation is also a very real problem for Åland and here too it must be seen against the breaking down of old traditions and ideas, and the emergence of a demand for a higher standard of living. In marked contrast to the Hebrideans the Ålanders have an extrovert character, readily adopting innovations, both in ideas and in techniques. The privately owned agricultural holdings vary according to size and situation and as a result the pattern of land-use and the nature of the subsidiary employment also vary. These social and economic inequalities among the population serve as an incentive to movement to areas with better financial opportunities; formerly to North America, and now to nearby Sweden, and especially to Stockholm. The merchant navies of Åland, of Sweden, and to a lesser extent of Finland also attract a number of Ålanders.

The agriculture of the comparatively small holdings on the Åland Islands has, in the past 50 years changed from subsistence farming to commercial production. Several main trends can be detected which have increased the value of agriculture as means of earning a living. Firstly there has been a remarkable reclamation of arable land from the softwood areas which earlier were used for growing natural hay and later in summer for pasture (see JAATINEN 1953, p. 66 and compare the proportion of arable land now used for grass growing). This land reclamation has come to an end on the mainland of Åland except for drainage work which is still being carried on round lakes and mosses. Secondly there has been a decrease in grain production and at the same time a change to spring wheat which is more profitable than the »old» rye and barley. Thirdly the introduction of a number of »new» crops increases the possibility of intensifying land-use. Sugar beet, onion, cucumber and turnip rape have attained great significance. These crops require considerable labour, but it is possible to grow them because of the great influx of potential labourers during the summer months — both ordinary holiday-makers and, more especially relatives working elsewhere, but spending their holidays in Åland.

In this way a profitable crop can be grown even in small fields. Nevertheless there are great risks with these crops, which risks are partly counterbalanced by the number and variety of the crops. The element of chance appeals to the mind of the islanders who put more value on the possibility of a good profit than on a low standard income. The fourth development has been the dairy industry. In its first stages a home industry, it was first changed by the organization of a number of small country dairies. As these became uneconomical, a big central dairy to serve most of the Åland Islands was erected in Mariehamn after the World War II. This organization with its extremely long transport routes for the milk, which is frequently produced in rather small quantities, would not pay without heavy subsidies from the government. It is a rather artificial method of maintaining a particular type of employment and land-use but it does help to counteract the depopulation of the islands. Dairying demands a considerable amount of work, at least on the part of the women, who take care of the milk, and the real profit is low. The mainland of Åland is an exception, for here the productivity of milk per acre of surface area (including all land and waters) is high. But on the archipelago, with its small and widely scattered rocky islands the profit is small. More emphasis on beef cattle rearing, now represented by the few calves kept on each holding — instead of dairy cattle would certainly be more profitable from a national point of view. At the same time it would make the dispersal of population over a great number of small islands to some extent unnecessary and promote bigger agglomerations, where people could be more economically provided with communications and modern amenities.

Fishing in the Åland Islands suffers from the disadvantages of long distances to the market, uncertainty of catch and lack of new capital. Fishing has been declining for several decades. Some attempt has been made to concentrate the catch upon more profitable fish. Previously Baltic herring, sold cured, was almost the only product. Now the aim is to catch fresh fish, including salmon.

The merchant navy employs at least as large a proportion of the working population in Åland as in the Outer Hebrides, but there is a distinct difference in the fact that Åland itself owns a considerable number of ships. This has its origins in the small-scale traffic of sailing boats, principally on the routes between Sweden, Finland and the Baltic ports which developed at the end of the last century. After the days of the big clippers (c. 1912—1935) the merchant navy of Åland acquired a considerable fleet of modern ships, some of them big motor vessels. Mariehamn is still the second shipping town of Finland. The shipping is in the hands of the Ålanders themselves both as owners and

crews, although Swedish ships are also very popular among them. In some parishes of the archipelago small-scale shipping is still maintained (Brändö). On the whole employment in the merchant navy is a very stable feature both in the economic structure of Åland and the life of the inhabitants. Moreover the school of navigation in Mariehamn provides opportunity for promotion on the navigation side as well as for engineers or stewards.

Except for a few local industries, such as sawmills, flour mills and brickworks, there has not been any industrial development in Åland. Work is now in progress on a promising submarine iron working at Nyhamn, just south of Mariehamn. In time this will employ several hundred men.

The islanders of Åland have been very ready to try other means of improving their situation. Several years ago they began farming mink and fox. The use of timber was still rather casual before the last war. It is now greatly improved and in addition to fuel wood pulp is exported.

Finally the Åland Islands have attained a high reputation among holidaymakers, which their situation near Stockholm naturally helps. This tourist industry is distinctive because it is really a »home industry», for many of the farmers and small cottars take guests in their own house or in a specially built summer house. The Swedish tourists on Åland are frequently middle or working class people who do not demand too high a standard of service. The only drawback is the shortness of season of only 2 months. Nevertheless Åland is visited by 30—40.000 tourists every summer.

Mariehamn, the only town in this area has grown remarkably fast during the past few decades and has attained, like Stornoway in the Hebrides, an important place in the economy of the archipelago. The town is a centre for the merchant navy of Åland, it is the shopping centre for most of Åland, it has schools and hospitals and the central dairy and finally it is the most important tourist centre for Åland. It has only small scale industries except for some boat building, a flourmill and a sawmill. In spite of the considerable building of new housing in the outskirts of Mariehamn there are a large number of people commuting to the town for work every day.

The Åland Islands lack railways, but a network of bus routes serves the country. External communications are represented by connections each night east (Åbo, Helsingfors) and west (Stockholm) and by several air connections every day, internal communications are also served both by small steamers and — during the winter — by air connections. The tendency for faster and more modern communications to by-pass formerly well served areas, has been partly counteracted by the new special air route for the SW-archipelago of Finland. This is of special value as the freezing and melting

periods of the ice make ordinary sea communications difficult to maintain. In spite of all these improvements in internal communications, some of them quite recent, it is impossible to serve every island adequately and quite a large group of people depend wholly on their own boats during the summer and sledges during winter.

The political status of the Åland Islands, the western marchland of Finland which has been partly self-governing since 1920 — has of course also had a great influence on the economic geography of those islands. Self-government has as its aim the maintenance of the Swedish language and nationality of the Åland Islands. Thus it is not possible for settlers from the mainland of Finland to obtain land until they have stayed there for a period of at least five years. On the other hand the rather high standard of life of the Ålanders and the smallness of the population make it necessary to »import» both unskilled and highly skilled labourers from the Finnish mainland. The immigrants have not so far altered the 95 % Swedish-speaking majority in Åland, because many of them are Swedish-speaking and because the Finnish-speaking persons are absorbed by the majority, the absence of Finnish schools being an important factor.

The self-elected isolation of Åland has somewhat restricted its economic activities, the development of its markets and the rise of new enterprises with their roots on the mainland of Finland. The separation from the Swedish market after the first world war was a heavy blow to old established trade relations, but developments since 1944 have been marked by a contrasting phase of close and promising association with the Finnish mainland.

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Fig. 24. Oblique view of the area north of Stornoway, comp. the text, p. 63. British Crown Copyright.

Fig. 25. Stornoway from north, comp. the text, p. 64, British Crown Copyright.

Fig. 26. Oblique view of the area east of Stornoway, comp. the text, p. 64. British Crown Copyright.

Fig. 27. Vertical view of Northton (Harris), comp. the text, p. 73. British Crown Copyright.

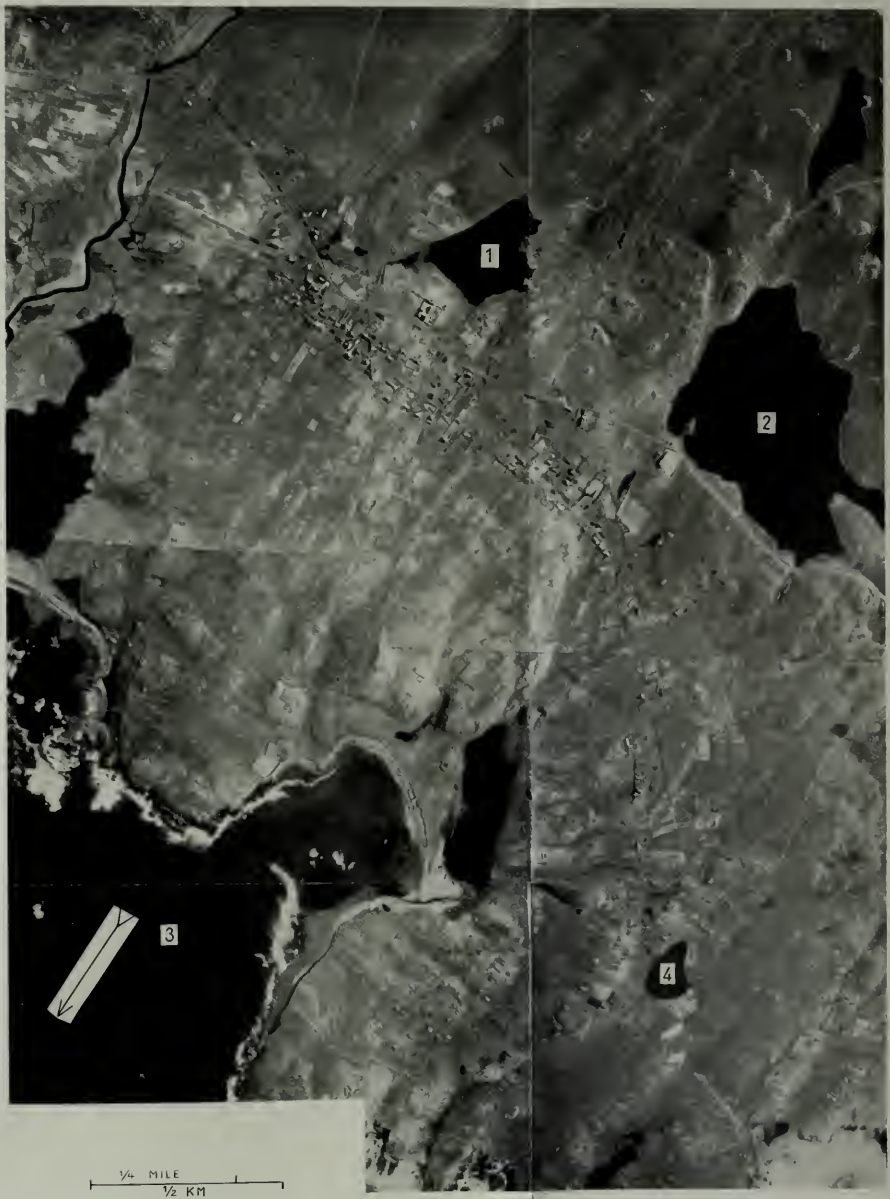

Fig. 28. View of the Arnol-Bragar-Labost area (Lewis), compiled from vertical airphotographs, comp. the text, p. 68. British Crown Copyright. 1 = Loch Grinavat, 2 = Loch an Dūna, 3 = Port More Bragor, 4 = The village of Labost is NE of the marked lake

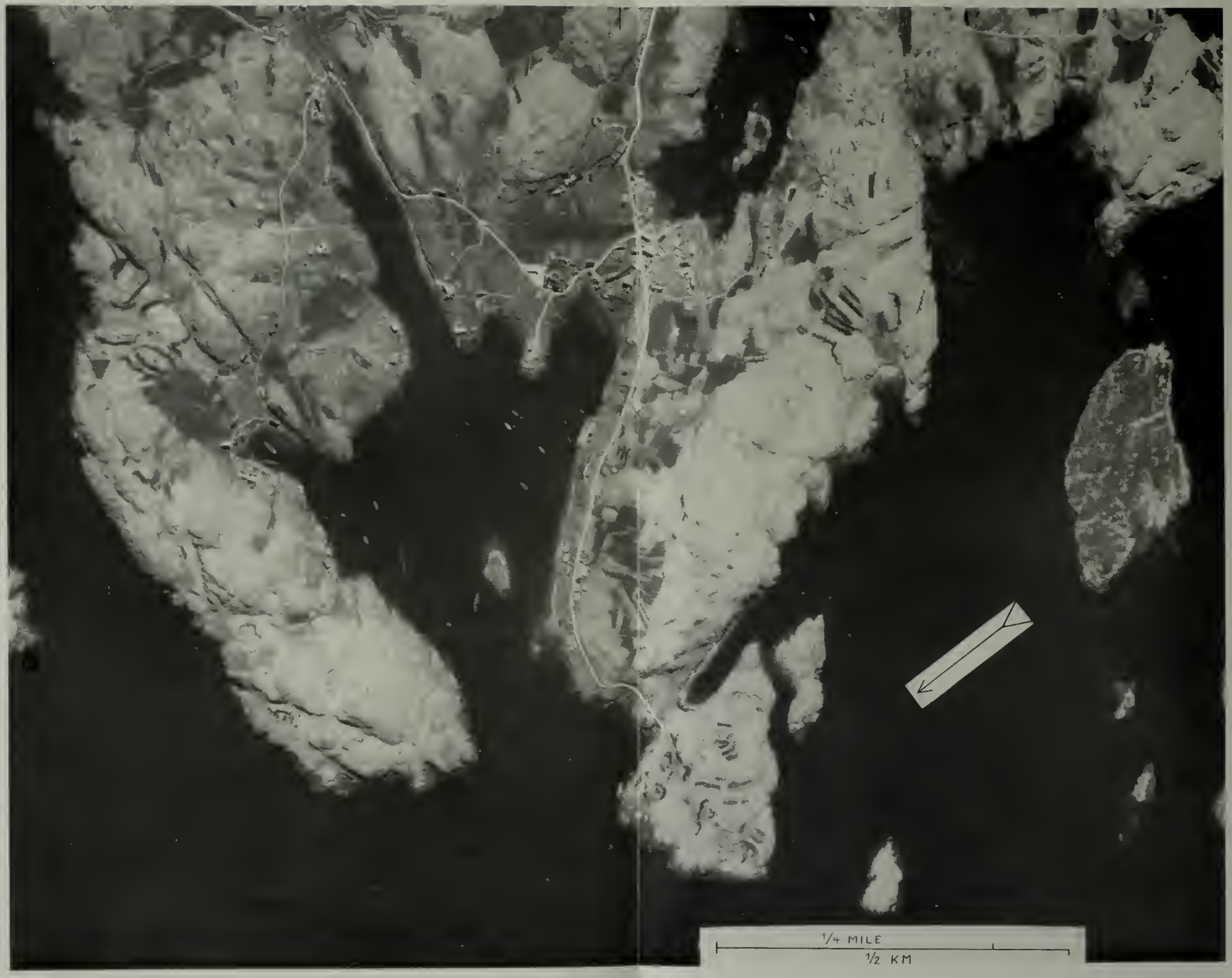

Fig. 29. Vertical view of the harbour area of Scalpay, comp. the text, p. 73. British Crown Copyright.

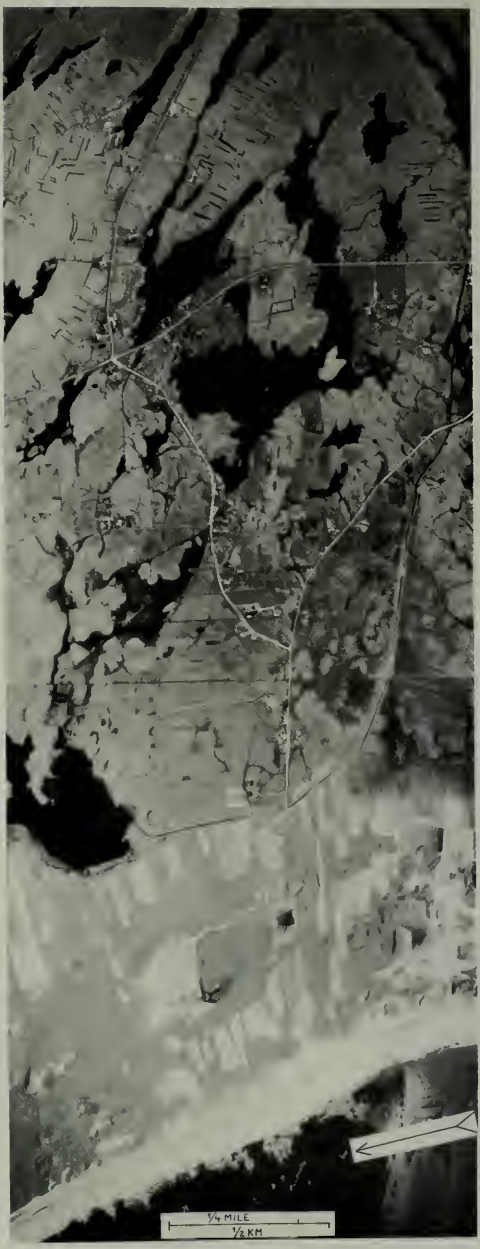

Fig. 30. Vertical view of Daliburgh, South Uist, comp the text, p. 79. British Crown Copyright.

ACTA GEOGRAPHICA 16, N:o 3

ON THE LATE-WISCONSIN DEGLACIATION IN EASTERN CANADA

BY

HEIKKI IGNATIUS

PART I. GLACIAL GEOLOGICAL OBSERVATIONS FROM NORTH-CENTRAL QUEBEC

HELSINKI 1958

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PRINTED BY TILGMANN

HELSINKI 1958

ACKNOWLEDGEMENTS

The present work was started already in 1951. In connection with the subsequent field work in eastern Canada and investigations made in several laboratories, of Yale University in U.S.A., and of University of Helsinki and the Geological Survey of Finland, I have had the pleasure of receiving much advice and assistance. I wish to thank for co-operation in field work members of NEALE's (1951) and LYALL's (1952) field parties, sponsored by Quebec Department of Mines, and Dr. I. W. JONES, Chief, Geological Surveys Branch, for his kind arrangements which made possible the field program in Quebec.

For advise in glacial geology particularly I owe a great gratitude to Professor R. F. FLINT of Yale University and Dr. Esa HYYPPÄ of the Geologica Survey of Finland.

My sincere thanks are also extended to Mrs. Toini MIKKOLA, M. Sc., for improvement of the manuscript, and to the Emil Aaltonen Foundation for a research grant.

INTRODUCTION

The primary purpose of the studies carried out by the author was an attempt to establish a pollen stratigraphic sequence in certain areas in north-central Quebec and Ontario and, by correlation of this sequence with the standard pollen stratigraphy of eastern North America, to elucidate the late-Wisconsin history in the investigated region (Fig. 2).

Glacial geological observations were made during the field work in Quebec. These observations are published in the present paper which is a modified part of a dissertation, presented in 1956 to the Graduate School of Yale University in partial fullfillment of the requirements for the degree of Doctor of Philosophy. The second part of the dissertation, dealing with the pollen stratigraphic studies, will appear in a later number of *Acta Geographica*.

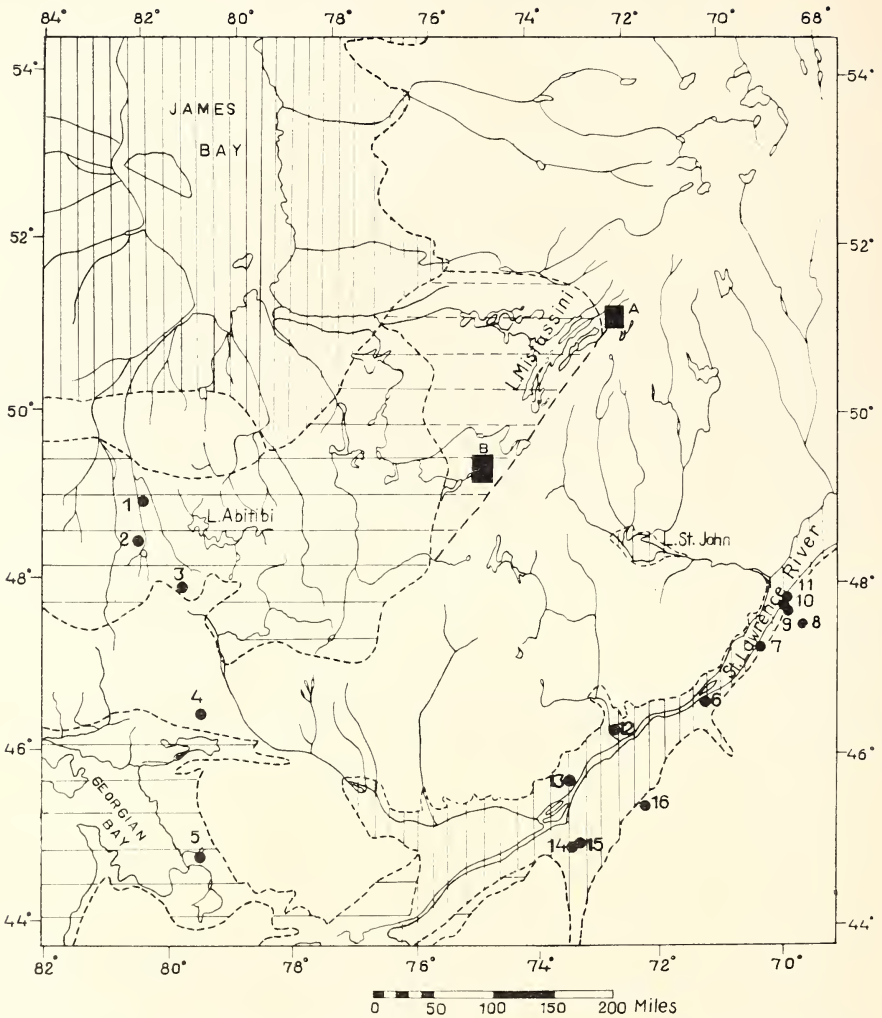


Fig. 2. Sketch map showing the location of the Bethoulat Lake area (A) and the Presqu'ile Lake area (B) in north-central Quebec. Pollen profiles from these areas, from eastern Ontario (sites 1—5), and from southern Quebec (6—16) will be published later. The areas of lateglacial lakes indicated by horizontal hatching and the postglacial marine overlap by vertical hatching (according to the Glacial Map of North America, modified).

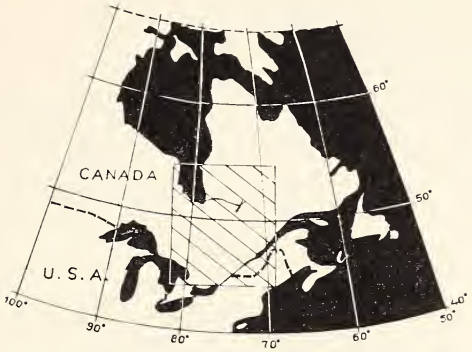


Fig. 1. Index map showing the region under consideration. The hatched area presented in Fig. 2.

PART I. GLACIAL GEOLOGICAL OBSERVATIONS FROM NORTH-CENTRAL QUEBEC

A. BETHOULAT LAKE AREA

General

The field work in the Bethoulat Lake area, Mistassini Territory, P. Q., was carried out during the field season of 1951. The main purpose of NEALE's field party, sponsored by Quebec Department of Mines, was bedrock mapping. Therefore it was not possible to study the Pleistocene geology of the area to the extent that a full understanding of the late-Wisconsin geology would require. Unfortunately, the glacial geological studies had to be limited almost exclusively to morphological analysis. In addition, the lack of a topographic map was a great handicap in the study of the land forms. Many of the Pleistocene features, however, could be observed and interpreted from the aerial photographs and also notes were made on the Pleistocene features on the ground. The map presented here (Fig. 3) is the result of combination of these two methods.

The division of the map is primarily based on morphologic features, for only these could be used as reasonably reliable mappable units. A considerable part of the area is placed under the heading »undifferentiated drift». This was thought to be a safe procedure so that greater errors would be avoided where the interpretation was difficult. Bedrock outcrops, although numerous in the area — perhaps occupying close to 20 per cent of the area — are not marked

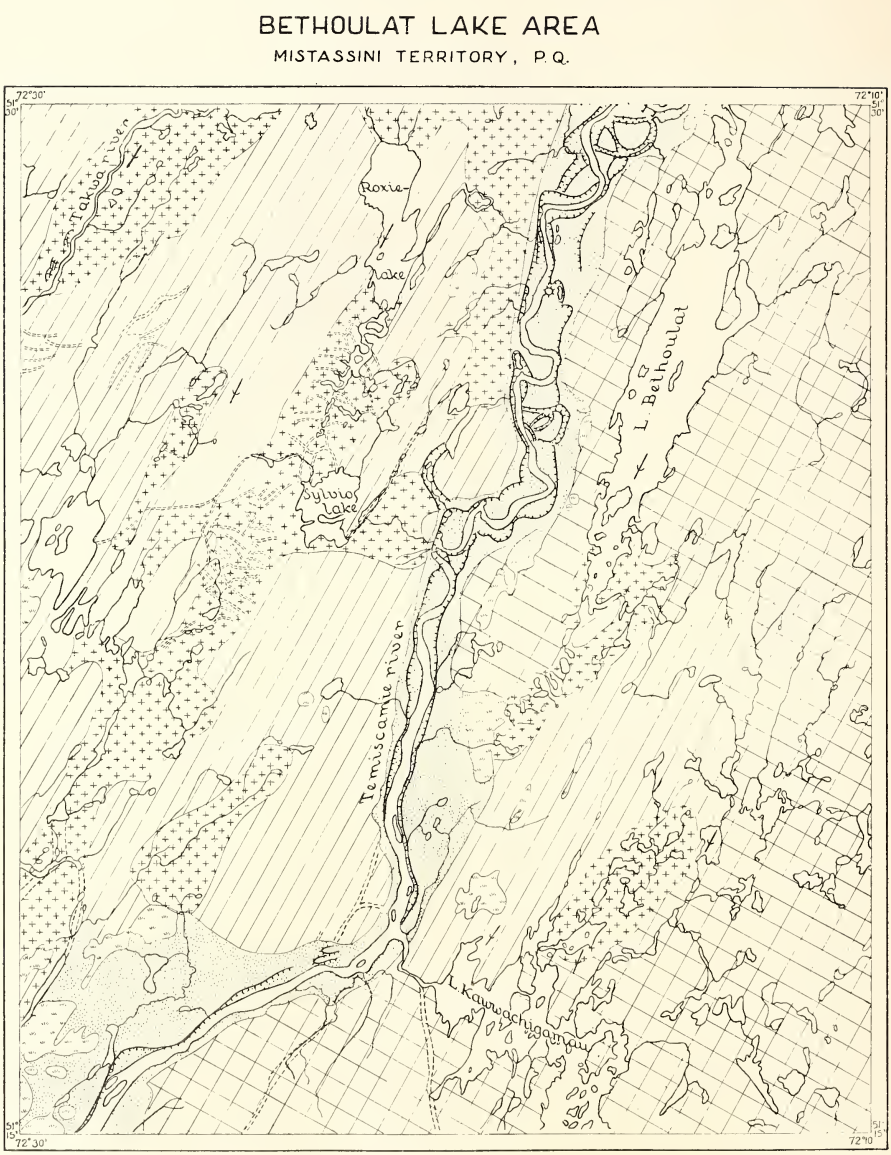
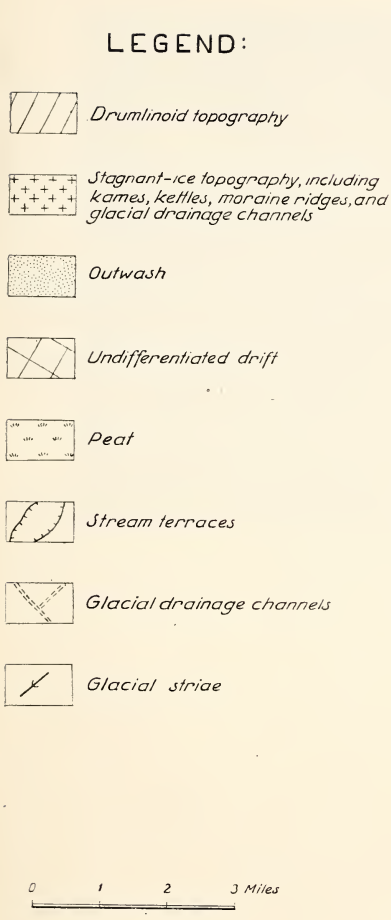


Fig. 3. Map on the Pleistocene Geology of the Bethoulat Lake area.

on the map. Reference is made to NEALE's bedrock map of the Bethoulat Lake area (NEALE, 1951; 1952).



Topography. — The area belongs to the Canadian Shield. When viewed from a hill top the level skyline is noticeable, indicating a former peneplane (Cf. COOKE, 1929; 1930). Above this general level arises a number of hills, obviously monadnocks consisting of rocks of more resistant lithologic composition than the surroundings.

In the small features the area is not at all level but highly undulating. The altitude of the Bethoulat Lake is about 1475 feet above sea level. Within the mapped area the hills and ridges rarely rise more than 300 feet above this level, but higher points exist in the more rugged height of land region east of the area, and also west of the area, i.e. Takwa Mountains, a group of higher hills. A typical feature of the topography, the linear landscape, will be discussed in connection with glacial erosion.

Bedrock. — The bedrock of the area consists of early Precambrian crystalline rocks, mostly gneisses and granites. The extreme southwestern corner is believed to be underlain by sedimentary rocks of late Precambrian age (Cf. NEALE, op. cit.)

Drainage. — Most of the area is drained by the Temiscamie River flowing southwest to Lake Albanel, and further to Lake Mistassini, with an outflow via the Rupert River to James Bay. The northwestern section is drained by the Takwa River directly to L. Mistassini. The southwestward trending linear topography is strongly expressed in the drainage pattern.

Glacial Erosion

The amount of glacial erosion in the area formerly covered by the Laurentide Ice Sheet is considered to be relatively small by many authors. A few

tens of feet is cited to be the average depth of glacial erosion in the Canadian Shield (Deane, 1950, p. 81). A generalization has been made according to which the central zone of the Laurentide Ice Sheet was only slightly, if at all, effected by glacial erosion. An intermediate zone outside the central area is supposedly characterized by more vigorous erosion. A broad peripheral zone is considered to be primarily depositional. In discussing this broad generalization, Flint pointed out the great effect of lithology upon glacial erosion and deposition (Flint, 1947, p. 86). The controlling effect of lithology can be well demostrated in areas where radically different types of bedrock occur. Thus in the Lake Simcoe district in Ontario the granitic Precambrian area was shown to be remarkably different from the sedimentary Paleozoic area with respect to the erosional and depositional features produced by glaciation (Deane, op. cit.).

In Low's opinion, the interior of the Quebec-Labrador peninsula was very little effected by glacial erosion. According to him, the center of accumulation of the »Labradorean Ice Sheet» was gradually shifted northward from a position near latitude 51 or 52 degrees to 55 or 56 degrees. (Dresser and Denis, 1944). Thus the Bethoulat Lake area may be considered to be situated in the southern part of the »interior». My opinion is, however, that the amount of glacial erosion in the Bethoulat Lake area cannot to be considered very »slight» when compared with regions farther south, i.e., in the »zone of glacial erosion».

The Bethoulat Lake area may be considered to represent a strongly linear glacial topography. Glacial deposition has played an important role in the formation of the present elongated landforms in this region, but it was observed in the field that a streamlined linear topography is characteristic also for the forms of the bedrock. I suggest that the streamlined forms in the bedrock were produced by repeated glacial erosion. The bedrock bosses as a rule show a well-developed stoss-and-lee topography. The northeastern (stoss) slopes are smoothed and gently sloping, whereas the southwestern (lee) slopes are steeper and have a much more irregular surface. The stoss-and-lee topography can be best observed on lake shores where the wave action has washed away the surficial deposits (Fig. 4). The arrangement of streamlined forms of bedrock definitely indicates that at least the last major ice movement was from the northeast to the southwest.

Glacial erosion may be considered to consist of two different processes: (1) abrasion and (2) quarrying. Flint concluded that in principle quarrying is quantitatively more important than abrasion (Flint, 1947, p. 77.). The granitic bedrock of the Bethoulat Lake area must have offered considerable resistance to glacial abrasion. On the other hand, numerous joints and fractures

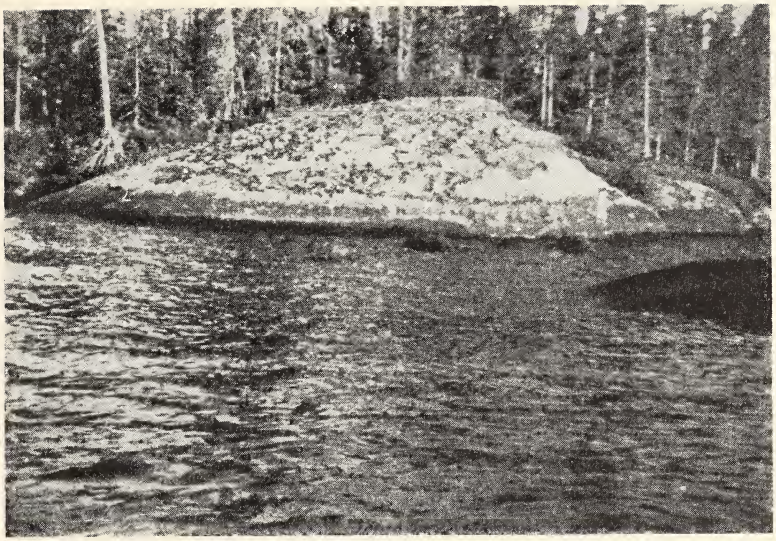


Fig. 4. Bedrock boss with typical stoss-and-lee forms. Eastern shore of Bethoulat Lake.

in the rocks greatly facilitated the plucking action of the ice. In connection with the field work in the area no quantitative figures could be stablished for glacial abrasion and quarrying. However, by constructing a hypothetical preglacial profile for a bedrock boss it appears that the quarrying process must have removed a much greater amount of rock than abrasion. This is particularly clear in cases where the present bedrock profile shows a step-like pattern. It is obvious that abrasion tended to produce a smooth surface after blocks of rock had been removed by the plucking effect. The abrasion, however, was insufficient to produce a continous surface; instead the effect of quarrying which took place prior to the last abrasion is well preserved in the forms of the long-profile. As a result the bedrock boss consists of a series of stoss-and-lee forms in a small scale. The first stoss slope which is the actual proximal slope of the boss, is the most extensive one; the other, smaller stoss slopes, are as truncated at their proximal ends. Assuming that no more quarrying occurred a continued glacial abrasion would eventually have produced an even, smoother surface. However, it is most unlikely that the glacial plucking effect would not have removed additional fragments from the lee sides.

The effect of quarrying and abrasion is also well illustrated by a special type of small bedrock bosses. In this case the lee side consists of two sections.

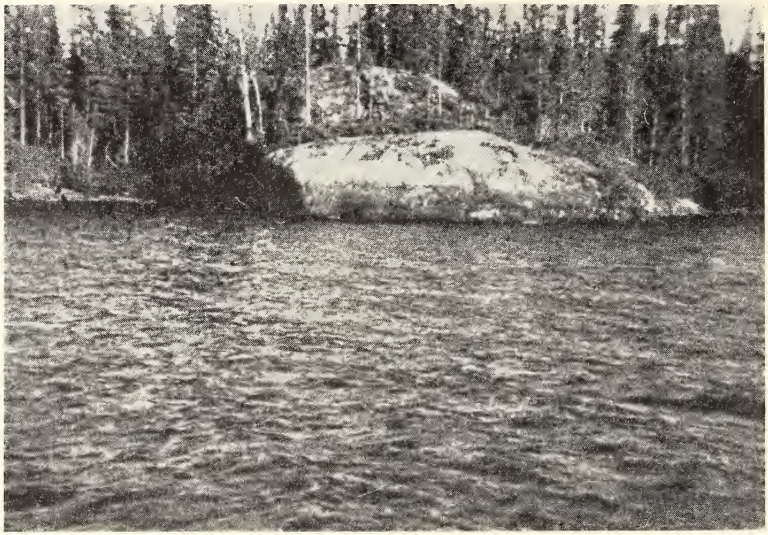


Fig. 5. Bedrock boss with a steep stoss side. The ice movement was from left to right, i.e., NE to SW. Eastern shore of Bethoulat Lake.

About half of the lee slope is rather smoothed and gently sloping. The other half is steep and its surface is irregular lacking any evidence of glacial abrasion. The rougher part of the lee slope extends toward the center of the boss. The smoothed part of the slope is considered to represent an old quarried surface, subsequently modified by erosion, whereas the inward extending part is a »fresh» quarried surface. This case suggests that the abrasion process was continuously in action, whereas quarrying did not take place all the time; yet abrasion could not keep pace with quarrying when the total erosional effect is considered.

The orientation and spacing of joints played an important role in glacial erosion. A closely spaced joint set, essentially perpendicular to the ice movement, greatly helped in the removal of blocks from the bedrock by glacial plucking. The existence of other joint sets was, of course, of additional assistance in the process. A joint set, essentially parallel to the ice movement, would, like any feature of structural weakness with such an orientation, facilitate the formation of linear structural forms. An interesting feature was observed on the eastern side and especially along the eastern shore of Lake Bethoulat. Some of the bedrock bosses seemed at first to have a stoss-and-lee topography indicating an ice movement from the southwest to the northeast

i.e., a direction just opposite to the ice movement revealed by the erosional forms of most of the bedrock bosses in the same area. Fig. 5 illustrates a bedrock boss which may first appear to suggest an ice movement from right to left — southeast to northwest — but a closer examination in the field showed that this was not the case. The steep, actually slightly overhanging termination of the proximal end of the stoss side was found to be a joint surface. The »missing» end of the stoss end was found to be submerged in the lake in front of the overhanging cliff. The jointing was of preglacial, probably Precambrian age; the stoss end of the boss must have slumped down after deglaciation. This rather misleading appearance was observed at several outcrops and could possibly cause confusion without detailed examination. Fig. 4 illustrated a »normal» long-profile of a bedrock boss with a well-developed stoss-and-lee topography in the immediate vicinity of the one shown in Fig. 5.

Striations. — In addition to stoss-and-lee forms, glacial erosional features indicating former ice movements are striations, grooves, and friction cracks. The trend of glacial striations is S 20—40° W and the average trend is 30 degrees west of south. The occurrence of the striae with respect to stoss-and-lee forms in the Bethoulat Lake area supports the inference that the ice flow actually was southeastward when these striations were formed. No other ice flow direction of importance was inferred on the basis of glacial striae in the area. It is true that in some places, local exceptions in the general trend were observed. In these cases, however, it could be established that the deviation from the main trend was controlled by the local topography. In a locality about four miles SW of Roxie Lake, an eastward trending, southward facing cliff showed striae which in general had an easterly trend. The height of the cliff was about four metres, the slope steep, about 75 degrees to the south. At a distance of 50 metres south of the cliff there was a rather steep upward slope. It is very likely that the shallow eastward trending trough-like depression actually is much steeper but is partly filled by drift. It is believed that the eastward trending striae were formed by ice flowing along the depression almost at right angle to the direction of the main ice movement. The behavior of ice flow with respect to minor irregularities in the topography has been studied in detail be Demorest who found a surprisingly delicate reflection of topographic irregularities in flow of ice (Demorest, 1938).

The striations caused by agencies other than flowing ice may cause some confusion, if not carefully examined. As an example may be mentioned »slicken side» features at some outcrops along the Temiscamie River. Striae caused by the pushing effect of recent lake and river ice may be more misleading, but even they can be differentiated from glacial striae when critically examined.

The former are as a rule somewhat curved and their occurrence is limited to the lake shores and river sides. Also, their occurrence shows a definite relationship to the shape of the water body.

Where postglacial weathering had destroyed the striations, the trend of the ice movement often could be inferred with the aid of larger grooves. The trend of the grooves in the Bethoulat Lake area agreed well with that of the glacial striae, i.e., S 30° W.

Friction cracks were observed on certain outcrops along the shore of L. Bethoulat. No deviation from the dominant ice flow was evident in these features, either.

Glacial Deposition

Most of the Bethoulat Lake area is covered by glacial deposits. These deposits, however, are not thick, and at many localities the underlying Precambrian rocks are exposed. It is probable that a considerable amount of the present bedrock outcrops represent areas of non-deposition or were exposed by glacial meltwater activity. In postglacial time (after deglaciation) various mass-wastage processes and the running water have removed the thin glacial cover in many places. Bedrock outcrops are numerous in the lake basins where wave action has washed away the unconsolidated cover. On the other hand, postglacial deposition has also covered some exposures, although most postglacial deposits have been laid down on top of glacial deposits rather than on bedrock.

Till is the most common glacial deposit in the area. In certain cases till forms depositional topographic features, but as a rule the till in the area is thin and only forms a blanket on the bedrock. A thin veneer of till, often less than one metre thick, was observed on higher ground. It is believed that the thickness of till in the depressions and lowlands is much greater. These areas are often occupied by lakes or peat bogs at the present time and the underlying deposits are thus hidden. Even where there is not much peat accumulation, the dense moss and shrub vegetation is a disturbing factor for surficial analysis.

The till was found to be of very sandy composition. Although no laboratory determinations have been made about the quantitative relations of different size grades the field observations suggest a very poor representation of the silt and clay fractions. As to coarser material, pebbles and cobbles are commonly present, although their amount rarely exceeds 20 % of the total volume. Boulders up to 3 metres and exceptionally 5 metres in diameter occur. They seemed to be more abundant in certain areas. The moraine ridge area southwest of L. Sylvio is very rich in angular boulders. Large boulders were also

Fig. 6. Perched boulder resting on bare bedrock, NW of Lake Sylvio.

very common in the region south of L. Bethoulat. In several places large concentrations of boulders were found in depressions showing a definite elongated arrangement. It is suggested that these »boulder streams» were formed from till by the washing effect of glacial meltwater streams. The post-glacial erosional processes may also have contributed in the removal of the finer debris, although the boulder streams are believed to be mainly of glacial origin. The boulders in these features as a rule show a certain amount of rounding. Angular boulders resting on bedrock may also be remnants of till (Fig. 6).

The Provenance of Drift. — It is believed that the bulk of the drift in the region is of local origin, i.e., it has not been transported far from the source area. Unfortunately, the bedrock geology north of Lake Bethoulat area is practically unknown. It was found, however, that the changes in lithology in the area mapped were reflected in the composition of the drift. Qualitative observations showed that most of the boulders were — or at least seemed to be — of very local origin. Thus not many boulders of an easily recognized rock, the »rusty-weathering hornblende granite» of NEALE (1951), were found outside of its occurrence in bedrock where it was an important component of the boulders.

On the other hand, it appears that a considerable amount of drift cannot be considered »local» in the true sense. Quartzite was an important component of surficial deposits throughout the area although this type of rock was not found in bedrock. According to the Geological Map of Canada an extensive outcrop of quartzite occurs north of the Bethoulat Lake area. If the quartzite material in the drift of the area was derived from the above mentioned region, it must have traveled several miles. It is probable that certain amounts of the »granitoids» similarly are of somewhat longer distance origin, although in spite of the scarcity of quantitative determinations the local influence seems to be strong, as stated above.

Only seven pebble counts were made in order to determine the provenance of the drift. In addition, the approximate lithologic composition of the coarser surface material was determined at several places. The results could by no means be considered reliable, but nevertheless they may give a general idea of the dominant rock types present on the surface of the drift.

If the assumption is made that the bulk of the »granitoids» is of local origin and the quartzites represent a longer distance transportation, the ratio between these two would indicate proportions of »local» and »long distance» material in drift. Two pebble counts from the area southeast of L. Bethoulat, one from ground moraine and one from a kame, gave essentially similar results. The ratio gtzite/gran. was in both cases 1 : 2. The amount of quartzite pebbles was 27 % of the total.

Provenance of the Outwash in the Temiscamie River Valley. — Five pebble counts were made from outwash gravel along the Temiscamie River. The quartzite component was found to be surprisingly high, 60 to 70 %. Although the number of analyses is small and limited to a distance of only twelve miles along the river, it appears that the rise of the quartzites present from 60 to 70 % in the upstream direction may be of some significance. This change supports the idea that the source rock lies north of the Bethoulat Lake area. The difference in lithology between the outwash material and the morainic material is striking. The Temiscamie outwash contains about 2.5 as much quartzite component as the morainic material. It should be mentioned that a pebble count from the western shore of Lake Bethoulat gave only 13 % of quartzite material. The material consisted of poorly sorted subangular to subrounded gravel, and it is believed to have derived from till without radical change in lithologic composition. The postglacial processes obviously have increased the number of fragments of local material, i.e. anorthosite and »rusty-weathering hornblende-pyroxene granite» (NEALE, 1951) due to disintegration. The percentage of quartzite is thus decreased, but this

case may also be considered to indicate a lower amount of quartzite in the till.

It appears justifiable to conclude that the bulk of the outwash gravel along the Temiscamie River was transported a longer distance than the drift in general in the Bethoulat Lake area. Furthermore, the transportation has likely been from the north toward south.

Drumlins and Drumlinoid Ridges. — Although the former ice flow is recorded throughout the area in the form of elongated ridges, this topography is best developed in the northwestern section. The linear topography is even more striking since much of this section is not forested, and the landforms thus can be studied in detail from the aerial photographs.

The average trend of the drumlinoid ridges is about 28 degrees west of south in the area east of Roxie Lake, farther west the trend is slightly more southern, S 25 W. The ridges are up to one mile, and exceptionally, up to a mile and a half long. The ridges are in general long and narrow. The shape may be expressed by the ratio between the short and long axis, i.e., the breadth and length. In the vicinity of Roxie Lake this ratio varies from 1 : 5 to 1 : 7. Farther southwest many ridges are much narrower, the ratio being as low as 1 : 15 and 1 : 17. The largest ridges may rise as much as thirty metres above the dales between them, whereas the very narrow ones sometimes are only few metres high. As a whole these topographic features show a great deal of variation in dimensions.

Due to the lack of cuts it is difficult to estimate the thickness of drift in these ridges. In some cases, however, as on the eastern side of Roxie Lake, numerous bedrock outcrops indicate that these ridges primarily are controlled by bedrock topography and covered by only a thin veneer of till. The accumulation of drift appears to be heaviest on the south-western ends — glacial lee sides — but often also at the north-western ends outcrops are lacking, typical for the central parts of ridges of the type known as »rock drumlins» (Cf. Flint, 1947, p. 123). The topographic form of a drumlin of this type is, of course, primarily an erosional feature, even if the thin drift cover may be of depositional origin. The so-called »crag-and-tail» effect can be observed in some cases. A good example is a ridge located two miles west of the southern part of Roxie Lake. The stoss-end consists in this case of a bedrock hill, about half a mile in diameter. On the lee-side of the hill the ridge continues a distance of a mile and a half. The feature is stream-lined becoming narrower and lower toward the lee-end. The fact that the ridge on the lee side of the bedrock hill has at least some drift cover is revealed by small gullies, cut by glacial meltwater.

The narrow drumlins in the vicinity of Lake Sam-Gunner may have no bedrock core, at least no bedrock was exposed within those features. Drumlins of this type have been suggested to be erosional rather than depositional in origin (Deane, 1950, p. 12). A knowledge of the inner structure is required before the origin of these features can be understood. It is probable that the long, narrow drumlins were produced by the interaction of glacial erosion and deposition. The giant groove-like appearance of the landscape seems to suggest the importance of the erosional processes, but it is reasonable to assume that deposition took place simultaneously.

The Lobate Moraine Ridges of the Roxie-Sylvio Lake area. — Of particular interest is the morainic topography which is present in the lowland area south of Roxie Lake. This topography is best developed in an area about six miles long and one to one and a half mile wide. The trend of the long axis of this area is thirty degrees west of south and thus agrees well with the general direction of glacial movement. The topography consists of closely spaced moraine ridges, essentially parallel to each other. The general trend of the ridges varies from east to southeast. A remarkable feature is the lobate pattern which is most striking on the western side of Roxie Lake and southwest of Sylvio Lake, although it can be traced throughout the area. The morainic pattern is obscure in places, and there the topography appears to be irregularly undulating or hummocky. The lobate character of the ridges can be easily observed on the ground because the area almost lacks a forest cover. The pattern is strikingly visible on aerial photographs. These moraine ridges show a definite concavity towards south — southwest (Fig. 7). In other words, their convex side is oriented towards the only established ice movement, which is from the northeast to the southwest.

Unfortunately, nothing is known about the inner structure and composition of these ridges. The surface is often characterized by a great amount of boulders up to two metres in diameter. As a rule the largest boulders are sharply angular or at least subangular, whereas the smaller ones often are slightly rounded. The surface matrix consists of sand and gravel. No mechanical analyses have been made but according to the field observations the finer sixe grades are lacking. Due to the coarseness of the matrix the texture is quite loose. Many of the boulders are free of lichen and are strewn on the surface of the ridges (Fig. 8).

The forms of the ridges are most regular in the area southwest of Sylvio Lake. There an individual ridge is 15 to 150 metres wide and two to fifteen metres high. The average figures for the width and height are approximately fifteen and five metres, respectively. A ridge is often continuous for 500

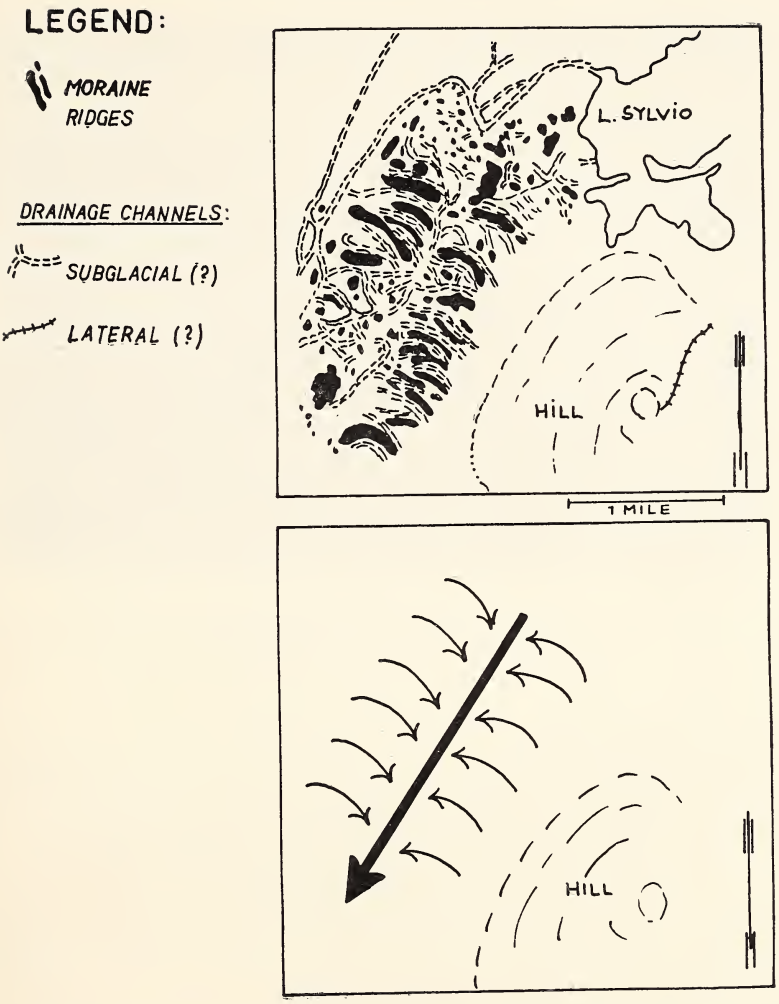


Fig. 7. Above, a sketch showing lobate moraine ridges and glacial drainage channels to the southwest of Lake Sylvio; below, the inferred drainage pattern marked by arrows.

metres, but rarely more than that. The ridges are exceedingly closely spaced. In fact, the depression separating two successive ridges from each other often is narrower than the ridges themselves. That means that the distance from crest to crest is influenced as much by the dimensions of the ridges as by the swales between them. In contrast to the steeply sloping ridges the depressions as a rule are flat, although their cross-profile may also be V-shaped, which is

Fig. 8. »Stagnant-ice topography» with moraine ridges, covered by boulders. About one mile west of Lake Sylvio.

especially true on the western side of Roxie Lake. The surficial material appears to be essentially similar to that of the ridges, although the flatbottomed type is even more sandy in composition, and boulders are less common.

The origin of this particular morainic pattern may be explained in many different ways. The limitation to morphological analysis is a great obstruction. The surface layer may give a very false impression about the inner composition (Mannerfelt, 1945). Fabric analyses showing a possible preferred orientation of pebbles would be of great importance (Holmes, 1941; Lundqvist, 1948). The following possibilities of mode of origin will be considered:

(1) End moraine. The moraine ridges under discussion have dimensions rather similar to those of a special type of small end moraines described from several glaciated regions. These so-called »annual moraines» (De Geer, 1940) are discussed in connection with the glacial geology of the Presqu'ile Lake area in the Chibougamau district. The typical »annual moraines», however, are much more regular in form. They may also have small lobate parts, but as a rule the concave side faces the known ice movement (Ignatius, 1949) i.e., just an opposite arrangement. Furthermore, the annual moraines seem to be limited to areas of subaqeous deglaciation (Hoppe, 1948). The annual moraines

are considered to be indicators of an at least slightly active ice; they have not been found in areas of a more or less complete stagnation.

It is probable that small end moraine ridges have been formed in many different ways. The annual moraines may have been formed mainly due to the push of the ice front (FLINT, 1947, p. 130). GOLDTHWAIT has (1951) described the formation of small end moraines in Baffin Island. Most of the material in these moraines was considered to be of superglacial origin and they may be considered to be »dump moraines» rather than »push moraines» (T. C. CHAMBERLIN, 1894, p. 525). Finally, the formation of an end moraine may have taken place under the ice margin rather than in front of it — this would be a »lodge moraine» of CHAMBERLIN (loc. cit.). HOPPE suggested that the »annual moraines» belong to the category of lodge moraines (HOPPE, 1948, p. 10). I believe that subglacial accumulation of drift produced gently sloping, broader moraines, instead of narrow, steeply sloping ridges, which might have been formed in front of the ice-margin.

In the discussion above glacial deposition is considered to be the main process necessary to produce a miniature ridge-valley topography. Glacial meltwater activity may also be responsible for such a pattern. Both ice-marginal and subglacial drainage has to be considered. If the deglaciation took place in superaqueous conditions — as it is believed to be the case in the Bethoulat Lake area — the ice-marginal streams may have greatly deformed the landforms in front of the ice-margin. Thus a relatively even surface may be »broken» due to channeling by ice-marginal waters. As a result of slow retreat of the ice-front the frontal channels may be quite closely spaced, and a pattern similar to the one under discussion may arise. In this case the ridges would be erosion remnants in contrast to the depositional types of end moraines.

If the ice completely stagnated in the final stage of deglaciation the orthodox type of marginal retreat would be impossible. In an uneven topography the hills would first emerge from the glacier due to the gradual thinning of the ice. Eventually, there would be isolated blocks of ice still occupying the lower ground while the higher topographic sites already had been deglaciated. In this case the subglacial meltwater activity would have its maximum effect, and in addition, the »subglacial topography» could be fairly well preserved, since there would be no marginal processes to destroy it. The superposition of superglacial and englacial debris, however, would be a disturbing factor. In fact, a thick ablation moraine might completely camouflage the subglacial features, if these were of small dimensions.

As has been pointed out by several workers, practically all drainage in a stagnant ice is subglacial. Most of the meltwater is formed by surface ablation

but the meltwater soon disappears into the numerous crevasses and holes characteristic of stagnant ice (v. KLEBBELSBERG, 1948, p. 41). In the case of stagnation the crevasses tend to stay open (FLINT, 1930, p. 629), since the ice is no longer competent to close them. The down cutting streams possess great erosive power (FLINT, 1947, p. 160; MANNERFELT, 1945, p. 22). A stagnant ice mass undergoing rapid melting has been compared with karst topography. The continuous undermining of ice by water is believed to produce a network of englacial and subglacial channels. It is obvious that the subglacial meltwater activity can produce a strongly channeled landscape. The pattern might be relatively regular under certain topographic conditions. The major streams would likely follow the valley bottoms. In a strongly linear topography, as in the area of the elongated drumlinoid ridges, it is natural to have a whole series of short tributaries flowing along the flanks of the ridges and joining the major streams in the depressions between the ridges (Fig. 7). This hypothesis would require a rather complete control of the subglacial drainage by the topographic forms in the final stage of deglaciation.

It is important to notice that a certain parallelism in moraine may simply be an ablation phenomenon (MANNERFELT, 1945, p. 14). According to this view the original arrangement of the superglacial debris may be preserved in the ablation moraine after the deglaciation.

In discussing the probable origin of certain moraine ridges in northern Sweden LUNDQVIST suggested that a practically stagnated ice-mass became suddenly activated, and as a result a system of tension fractures was formed. Most of the »dead-ice moraines» were supposed to have originated by slumping of debris into the hypothetical crevasses (LUNDQVIST, 1943). A similar mode of origin might be possible for the lobate morainic pattern in the Bethoulat Lake area. It is however, unlikely that conditions occurred in the Roxie-Sylvio L. region which could have produced a regular pattern of tension fractures in the ice, for the topographic differences seem rather insufficient for the development of a narrow ice-tongue advancing in an elongated depression. An event of that kind would be more likely where possibilities for the development of a »valley glacier» would exist.

I have presented above a rather lengthy discussion on the lobate morainic pattern in the area under consideration. It may yet be justified, for these features may supply critical information as to the probable position of the ice-margin in the area, a matter that will be considered later.

Kames. — Several conical accumulations of drift were observed in the area. The largest ones I examined on the ground were up to 70 feet high, but according to R. SABORIN (oral information), still higher knolls of drift rising close to

Fig. 9. Kame knoll located one mile north of Lake Sylvio.

100 feet above the surrounding country occurred along the Takwa River in the northeastern section of the area. Due to the lack of cuts nothing is known about the inner structure of these accumulations of drift; on the basis of the morphological features they were classified as kames.

Kames were noted from many sections of the area, but they were most abundant in areas indicated on the map as »stagnant-ice topography». They were closely associated with kettles and with morainic accumulations of ridge-like or irregular, hummocky form. The channeling effect of glacial meltwater was usually much in evidence in the surroundings of kames. It also seemed that the kames were situated in topographically low areas elongated depressions. Individual isolated kames were observed, but more often a group of them was recorded.

Their arrangement was not always random; three great conical kames formed a southwestward trending linear feature in the stagnant-ice topography about one mile north of Sylvio Lake.

The surface of these kames was covered by exceedingly coarse debris: pebbles, cobbles, and boulders. The texture was very loose, and as they sometimes almost lacked a vegetative cover, surface material could easily slide down along the steep slopes sometimes representing the angle of repose. The

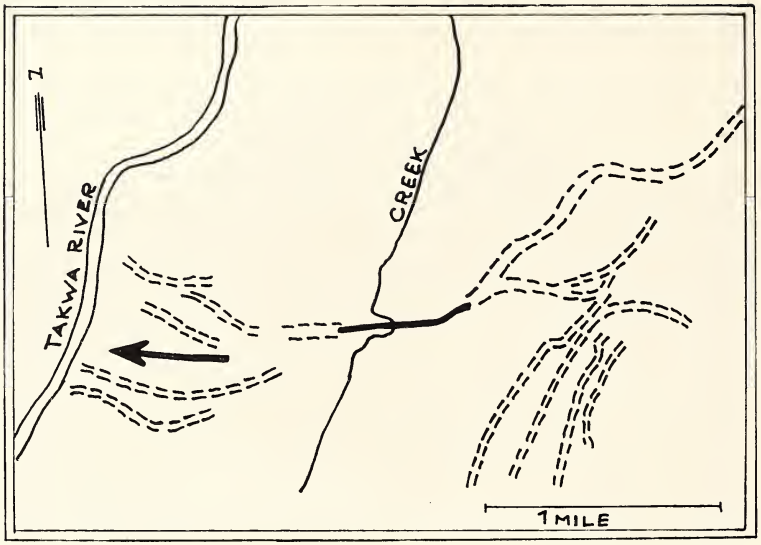


Fig. 10. Subglacial (?) drainage channels crossing the present drainage in the northwestern section of the Bethoulat Lake area. The inferred direction of flow marked by arrow. Notice the small esker-like ridge crossed by the creek.

largest surficial boulders were very angular; the pebble size debris instead showed a considerable degree of roundness.

It is quite possible that these kames contain well sizesorted drift of finer fractions camouflaged under the cover of the coarse debris; the few tests that could be made by digging small holes — less than two feet deep — seemed to suggest that the degree of rounding increases and the grain size decreases below the surface.

On the basis of the data available it seems justifiable to include the kames of the Bethoulat Lake area within the complex of ablation moraine (Cf. FLINT, 1947, p. 148).

Eskers. — No eskers were with certainty observed in the area. It is possible that certain minor ridges occurring with glaci·l meltwater channels are eskers of a special type (Fig. 10; Cf. MANNERFELT, 1945). Minor eskers of this type may also be hidden due to the superposition of ablation moraine cover. Thus for example the ridges protruding into L. Sylvio, and some other ridges in the same region, which were mapped as moraine ridges, may actually not be moraines at all but the »subglacially engorged eskers» of MANNERFELT.

»Lateglacial» Drainage

When the Bethoulat Lake area was being deglaciated the hydrologic conditions were radically different from those of the present time. Thus the evidence indicates that in certain cases the glacial meltwaters cut right across the present drainage (Fig. 10). It is not firmly established to what extent these glacial drainage channels were subglacial, lateral, and »proglacial», i.e. free outflowing streams outside the glacier margin. On the basis of examination on the ground and the interpretation of the aerial photographs it is suggested that most of the channeling in the the elongated depression of the L. Sylvio — L. Roxie area was produced by subglacial meltwaters (Fig. 7). It should be noted that this statement does not necessarily imply that the moraine ridges have been entirely formed by subglacial meltwater; nevertheless, whatever the origin of these ridges may be (Cf. discussion above) convincing evidence exists for the activity of glacial, and likely subglacial, meltwaters in that particular area.

It seems rather definite that certain signs of glacial meltwater activity which occur in higher positions along slopes or even almost at the summits of hills were formed by lateral meltwater streams, for in certain cases the channels were incomplete, with a missing half. Such terrace-like appearance is easily understood if the assumption is made that the glacier formed the other slope of the channel (Cf. MANNERFELT, op. cit.).

Origin of Lakes

Lakes were preferred to bogs as sampling sites in pollen-stratigraphic studies. As the mode of origin of a lake is of primary importance in this connection — for it is obvious that no lake can yield a limnic sedimentary record older than the lake basin itself-special attention was paid to this matter. The origin of the lakes in the Bethoulat Lake area is so closely associated with the glacial geology that the topic will be treated here, although lakes really are of greater importance for the pollen studies (Part II).

The following genetic classification is suggested for the lakes in the Bethoulat Lake area:

(1) Lakes controlled primarily by preglacial topography
(2) Lakes due to glacial erosion
(3) Lakes due to glacial deposition
(4) Lakes formed mainly due to the effect of glacial meltwater.
(5) Lakes formed by postglacial processes.

(1) It is probable that at least some of the lake basins in the area are essentially preglacial features. Naturally, it is not maintained that the glaciation failed to effect these pre-existing basins, on the contrary, a combination of glacial erosion and deposition is responsible for a considerable modification of the pre-existing features. Thus the separation of lake type (1) from (2) and (3) is rather hypothetical and cannot be firmly established with the information available. It is likely that the site occupied at present by Lake Bethoulat was a lowland area before glaciation. Certain small, narrow lakes such as a northwestward trending lake in the southeastern corner of the mapped area may be located in preglacial or interglacial depressions (channels?) choked by glacial deposition and might be classified as lakes of types (3) and (4) rather than included in the first category.

(2) The elongated lakes occupying dales in the drumlinoid landscape west of Roxie Lake may be considered to be primarily of glacial erosional origin. As mentioned before, the drumlinoid topography is, at least in some places, a feature of the bedrock. Elongated depressions would exist even if the thin drift were stripped away. Glacial erosion may have produced such a pattern by gouging rather independently of the pre-existing topographic forms. Immediately east of the Bethoulat Lake area, in a region of considerable relief, many of the lakes appear to be in bedrock basins. Glacial erosion must have played an important role in the formation of these basins. This area was not examined on the ground, but some observations were made from airplane and the available aerial photographs, which covered the territory eastward to longitude 72°00′.

(3) Lakes formed by glacial deposition can be subdivided into two types: A. lakes formed by the damming effect of drift, and B. lakes situated in depressions in drift, independent of the underlying bedrock topography. Due to the lack of subsurface data it was not possible to determine the total effect of damming by glacial deposits. It is obvious, however, that even in the cases where the lakes are located in depressions present in the bedrock, the actual lake levels are to a great extent controlled by drift. Thus the northern part of L. Bethoulat is dammed by the outwash material of the Temiscamie River valley. A former channel leading southward and then westward toward the Temiscamie River from the southern end of the lake seems to be filled by morainic material (Cf. map, Fig. 3).

B. Most of the small lakes are due to topographic forms in the drift, and are thus not bedrock-controlled features. Kettle lakes belong to this category. They occur throughout the area but are more frequent at certain localities. Good examples of groups of kettle lakes are found southwest of Lake Sylvio

and, in the northern part of the area, about halfway between Roxie Lake and Temiscamie River. It appears that some of the small lakes are not located in kettles nor are they controlled by any definite moraine pattern, but they are due to minor irregularities in the drift surface.

(4) The erosional effect of glacial meltwater in superaqueous conditions is considerable (Cf. MANNERFELT, 1945). It is likely that the crescentic lakes in the vicinity of L. Sylvio are located in former meltwater channels. Some of the strongly elongated lakes probably are of similar origin. South of L. Roxie, a whole series of small lakes extends towards the southeast. These lakes are believed to occupy the site of a major meltwater channel. The crescentic bays in the southern part of L. Roxie are due to channels tributary to the main meltwater channel. East of Roxie Lake certain small lakes seem to be located in »pot-holes», due to glacial meltwater action.

(5) Lakes have also originated in postglacial time. The degrading Temiscamie River has cut a series of terraces in the glacial fill. Small lakes and ponds occur in many of the abandoned channel segments present on the terraces.

Pools of stagnant water, developed on surfaces of bogs, are exceedingly common in the Bethoulat Lake area. These »secondary» ponds are not to be confused with the »primary» bog ponds, the latter being results of the filling-in process of small lake basins.

B. PRESQU'ILE LAKE AREA

General

In the summer of 1952 Pleistocene geological observations were made in the Presqu'ile Lake area, Chibougamau District, under similar conditions as in 1951 in the Mistassini Territory. In many respects the glacial geology of these two areas is of similar nature. Hence it is not considered appropriate to present a detailed discussion on the glacial geological features of the Presqu'ile Lake area here. Important differences do exist, however, between the two areas in this respect, and in the discussion below the main emphasis will be on the features not present or different from those of the Bethoulat Lake area. It should also be pointed out that the glacial geology of the region immediately north of the Presqu'ile Lake area has been treated previously by NORMAN, and a reference is made to his description (NORMAN, 1938).

A map is presented here (Fig. 11) with selected Pleistocene features. Only striations, eskers, and end moraines of a special type, i.e., the so-called »annual moraines», are marked on the map. Hypothetical ice-marginal positions have

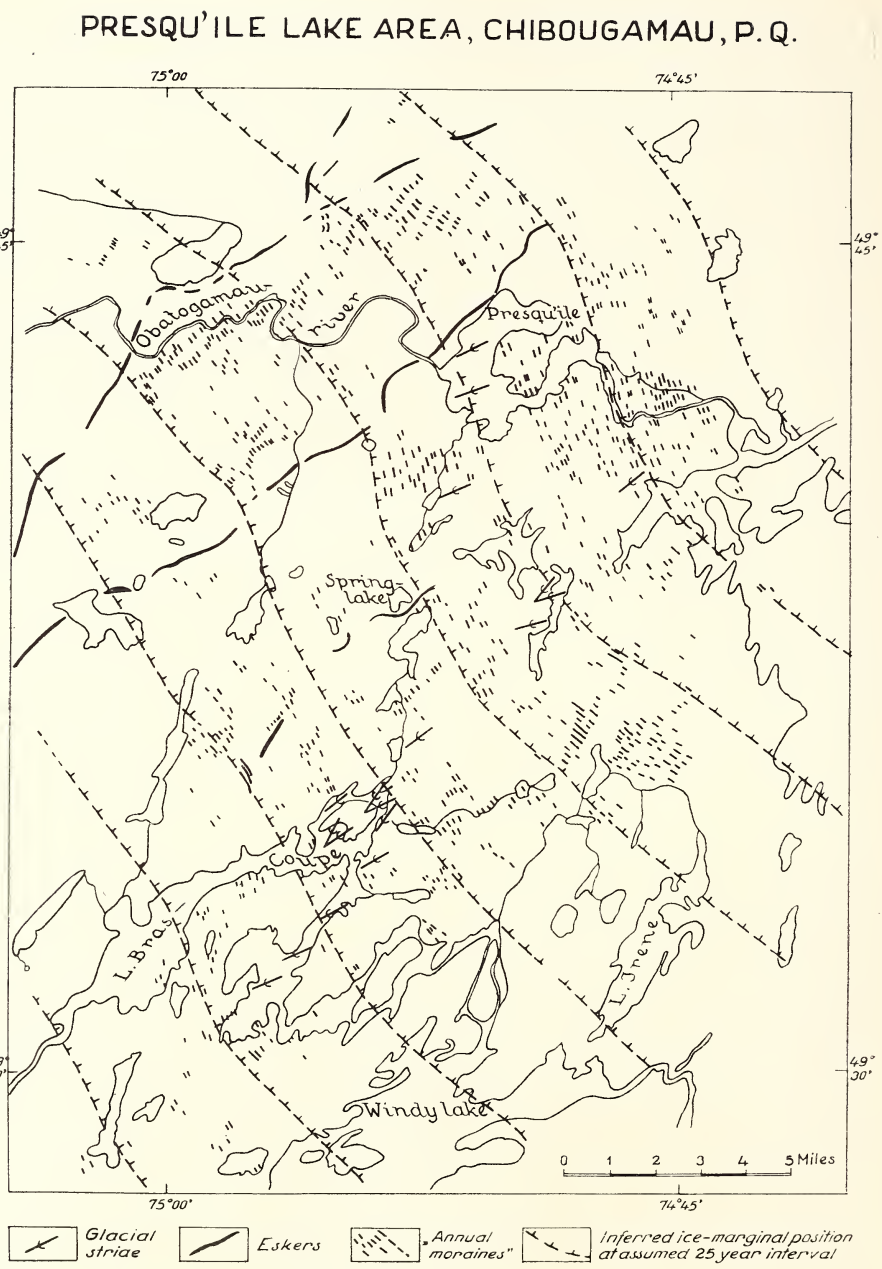


Fig. 11. Map showing the trend of probable ice-marginal positions in the Presqu'ile Lake area.

also been added in order to illustrate the probable trend and the possible rate of retreat of the ice-margin within the Presqu'ile Lake area.

Topography. — On the whole the area is exceedingly level. The relief rarely exceeds 100 feet. At many localities, particularly in the northern section of the area, extensive flat surfaces occur, with a relief of only a few feet. The altitude of the larger lakes in the area is slightly more than one thousand feet above sea leve. Thus the altitude of L. Bras-Coupé in the southwestern section is about 1.135 feet. Higher hills exist in the vicinity of the area, such as Mt. Springer in the north at 1.825 feet.

Drainage. — The trend of the major drainage is westward. The northern section is drained by the Obatogamau River. Many of the lakes in the southern section are actually wider parts of the Opawica River. Eventually all the waters enter James Bay.

Ice Movement

Striations. — The ice flow is well recorded in the area by numerous glacial striations. The range of the trend of striations is notably great: S. 30—70 degrees W. Most frequently the striations revealed an ice flow about 50 degrees west of south. Originally I considered the deviations from this trend as only local exceptions without any regional significance, but after a great number of measurements were made the results seemed to indicate a definite arrangement in the changes of the trend. This inference was supported by the observations from three sites where two directions could be observed side by side, although no crossing glacial striae were noted with certainty. The angle between these two directions was about thirty degrees (Cf. map., Fig. 11).

Other Indications of Ice Movement. — The general glacial erosional forms — stoss-and-lee topography — revealed a more southerly ice flow than most striations, about S 35 W. The same direction was represented in the few drumlinoid ridges that were observed. It could not be established whether these were »rock drumlins» or »drift drumlins», but if the former were the case, they would be additional indicators of the trend of the general glacial erosion.

Eskers. — Two great esker systems cross the northwestern section of the area. Actually these eskers are much wider than indicated on the map, for only the sharp esker ridges were separated on morphological basis. Extensive sand plains occur in connection with these eskers (Cf. NORMAN, 1938), but it is not likely that the sand plains represent original esker forms. Some of them, however, may be original deltaic surfaces, stratified drift being spread in ponded waters at the time of deglaciation. It is interesting to observe that the

trend and branching of the eskers agree well with the striations, even forming an angle of about thirty degrees, as in the case of striations. This is a matter that could hardly be only coincidental.

»*Annual Moraines*»

A striking feature in the glacial morphology of the Presqu'ile Lake area is the pattern formed by sets of small end moraines. These moraine ridges are identical with the »annual moraines» of Fennoscandia (De Geer, 1889; 1940; Sauramo, 1929; Hoppe, 1948), an inference made already by Norman (op. cit.) in the Chibougamau area.

The ridges are usually only 10 to 15 feet high, but may reach 30 feet. Their shape shows a great deal of variation, but commonly the slopes are quite steep, approaching the angle of repose of the material. The abundance of great boulders is characteristic for these moraines. The surficial material was found to be of very sandy composition.

The inner structure and composition of these ridges could not be studied in the Presqu'ile Lake area, but it is reasonable to assume that they are here, as elsewhere, composed mainly of till. Fabric analysis made from the »annual

Fig. 12. Typical »annual moraine» in the Presqu'ile Lake area. The photograph was taken from the northeastern, i.e., ice-contact or »proximal» side of the moraine ridge.

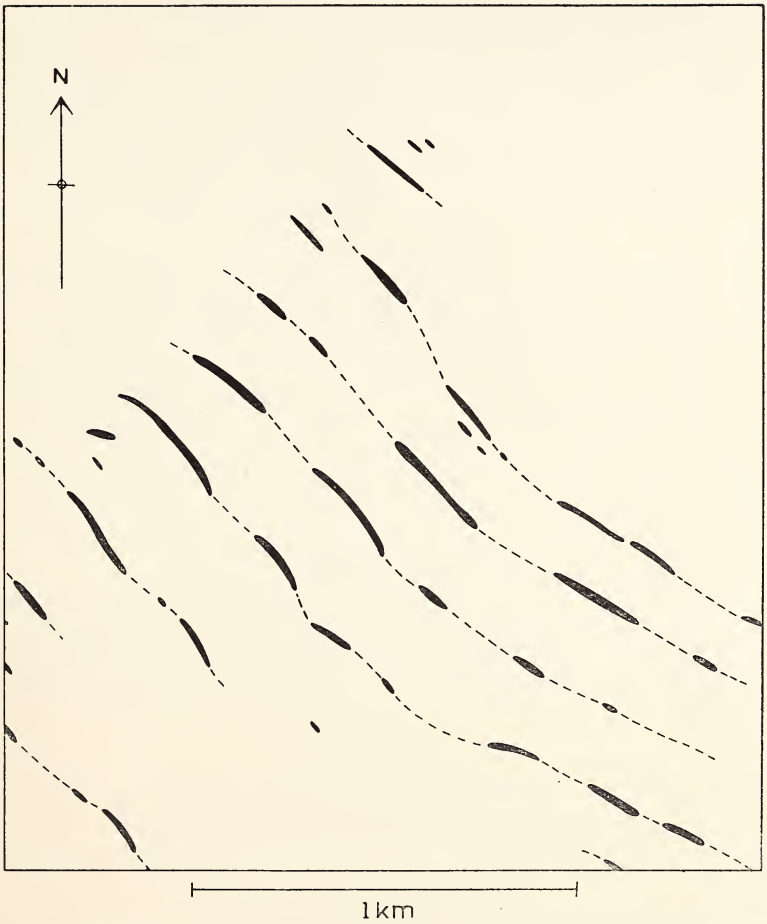


Fig. 13. »Annual moraines» and inferred yearly ice-marginal positions in the area three miles NW of Presqu'ile Lake.

moraines» have revealed results similar to those from ordinary basal till, i.e., with a preferred pebble orientation parallelling the direction of ice flow (Ignatius, 1949).

In some cases a minor moraine ridge is as superposed on a wider »annual moraine», forming a distinct crest (Fig. 12). Such a morphologic expression particularly, as the form of these ridges in general, would seem to refer to »push moraines» (Cf. Flint, 1947), although the fabric analysis from the inner structures might suggest »lodge moraines» (Cf. Hoppe, 1948). In many respects the »annual moraines» resemble small end moraines formed by existing glaciers.

The spacing and arrangement of the »annual moraines» in the Presqu'ile L. area shows a great deal of variation, but on the whole the ridges form a regular pattern. An example of this is illustrated in Fig. 13. By measurements on the ground and the examination of the aerial photographs I found 600 feet to represent the average interval between two successive ridges.

Indications of Glacial Lakes.

A former beach ridge consisting of sizesorted gravel was observed on the crest of a bedrock ridge about two miles SW of Spring Lake. 1.400 feet is a rough estimate of the altitude of this beach ridge, but it is likely a too low figure. Probable lower levels of former strandlines occurred around the northern shore of L. Presqu'ile where a series of small terraces were noted along the esker flanks.

It is also reasonable to assume that many of the »sand plains» in the area record former glacial lake levels, being levelled by wave action, and as stated above, some of them may represent original deltaic surfaces formed in front of the ice-margin at the mouths of glacial meltwater streams.

Varved clays were not found from the area, but clay deposits could be overlain by sand. Clay might also be hidden underneath peat, for the amount of borings made in the bogs of the area is inadequate to exclude such a possibility.

C. SUMMARY OF THE GLACIAL GEOLOGICAL OBSERVATIONS: COMPARISON WITH EARLIER INVESTIGATIONS

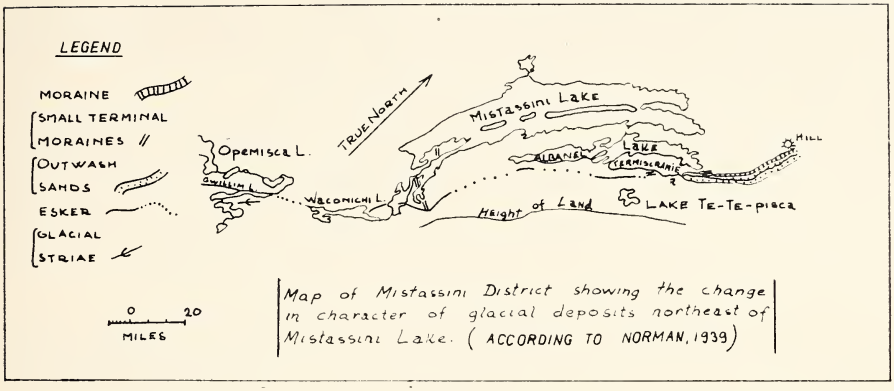
Chibougamau District

(1) The evidence seems to suggest that the dominant ice flow in the Presqu'ile Lake area was S 35—40 W but a more westerly direction was caused in the last phase when the ice had become much thinner and the effect of local topography was increased.

(2) The pattern of »annual moraines» supplies suggestive evidence as to the probable position of the ice-margin, and an average annual recession of 600 feet is inferred for the Presqu'ile L. area.

(3) Various lines of evidence indicate that the deglaciation of the above area took place under »subaqueous» conditions. A reasonable assumption is that the glacial lake in question was a part of glacial lake Barlow-Ojibway.

(4) These suggestions are in good agreement with NORMAN's results from the region north of the Presqu'ile L. area.



Map of Mistassini District showing the change in character of glacial deposits northeast of Mistassini Lake. (ACCORDING TO NORMAN, 1939)

Fig. 14. Sketch map made by NORMAN (1939) on the deglaciation in the Mistassini Territory (redrawn).

Mistassini Territory

According to NORMAN (1939), an end moraine occurs along the upper part of the Temiscamie River (Fig. 14). This northeastward trending feature was supposedly built by »a slight northwestward advance of the upland ice sheet towards the lake.» (op. cit., p. 64). This moraine is indicated on the Glacial Map of North America (FLINT and others, 1945).

In connection with the field work in the Bethoulat Lake area in 1951 I was not able to find any evidence supporting NORMAN's hypothetical northwestward advance of the ice sheet. In fact, the field evidence seems strongly to oppose such a glacial movement.

(1) Striations indicating an ice flow other than the dominant northwestward trending one were not observed. The same is true with other glacial erosional features.

(2) The provenance studies indicate a general transport from the north to the south rather than from the east to the west.

(3) In my opinion, the morphologic evidence does not reveal such a northeast — southwest trending ice-marginal position in the Bethoulat Lake area, as there should be according to NORMAN. The postulated »end moraine» on the western side of the Temiscamie River does not seem to exist at all. The glacial morphology in this area suggests east-west trending ice-marginal positions, if any.

It is likely, that Norman's suggestion as to the northeastern limit of a former glacial lake is quite correct. Whether the extensive water body oc-

cupying the Mistassini basin at the time of deglaciation actually was a part of the glacial lake Barlow-Ojibway is a matter that still requires additional evidence in order to be proved, but it seems probable.

I have shown in this paper the field evidence from the Bethoulat Lake area indicating that this particular area, at least, was deglaciated under »superaqueous» condition, i.e., no major glacial lake was present in this area. By the examination of aerial photographs the same seems to be true of the country immediately to the east and west of the area. These observations are thus in good agreement with NORMAN's hypothesis.

As to the nature of the outwash deposits in the Temiscamie River valley, I do not agree with NORMAN. According to him, »free outflowing streams from the ice built up the outwash plain against the moraine» (NORMAN, op. cit., p. 64). If such were the case, one would expect to find evidence for the postulated outwash transport from the east. Earlier the apparently northern rather than eastern provenance of the drift was pointed out. In addition the sedimentary features of the outwash do not indicate such a transport from the east and deposition against the hypothetical moraine.

The stratification is mostly rather horizontal, yet gently dipping towards wouth or south-east. NORMAN's hypothesis would require a westward dip. In places where the present Temiscamie River has cut its channel close to the western limit of outwash, one would expect to find steeper westward dipping strata, but this was not the case.

Nothing definite can be said about the change in grain size. There seemed to be more of the coarser size grades in the upstream than in the downstream area, but this is by no means certain. It should be remembered that only a very limited part of the Temiscamie River valley was examined on the ground. On the other hand, there was no indication of an increasing grain size towards east, and yet that ought indeed be the case if the outwash streams had entered the Temiscamie River valley from the east alone.

It might still be suggested that the present sedimentary features cannot be used as criteria, as they were formed in postglacial time and thus do not represent primary features of the outwash. The Temiscamie River is, however, a degrading river and has cut down a series of terraces in its former fill which I believe is from the time of deglaciation. Obviously only locally and temporarily is this river aggrading.

In summarizing all the field evidence available it thus becomes apparent that no features observed seem to support an eastern origin of Temiscamie River outwash. Instead, a northern source of the drift and a transport from the north seem to be the most likely ones. As I did not find evidence for the

existence of NORMAN's northeastward trending end moraine, it seems justified to reject the hypothetical westward advance of an upland ice sheet from the higher areas east of the Mistassini basin. This statement does not exclude the possible occurrence of local ice caps in the higher areas slightly after the general deglaciation of the region, but I do not believe that any local readvance from the eastern area extended to the Temiscamie River. Such an event ought to have left definite traces.

An examination of NORMAN's map (Fig. 14) calls attention to a peculiar situation: why should the obvious continuation of the »giant esker», the outwash body in the Temiscamie River valley, represent a different glacial phase? The esker apparently was formed more or less in a transverse position with respect the ice-margin, as is supported by NORMAN's observations from the southern end of the Mistassini basin where small end moraines occur perpendicular to the esker which is roughly parallel to the striations.

I suggest that the ice-margin was gradually retreating northeastward toward a glacial center. As long as the glacier margin terminated in the great standing water body which filled the Mistassini Basin, calving must have been an important factor in ice recession. When the ice-margin had retreated to the region northeast of the present Lake Mistassini, the conditions of deglaciation had changed. The glacier no longer terminated in a glacial lake, and the formation of the giant esker was brought to an end. Calving was no longer activating the ice-margin, by removing of ice-bergs from the glacier terminus and the formation of a stagnant end-zone could easily take place. The more rugged topographic conditions must have favored the development of local stagnation. A considerable climatic amelioration, which is reasonable assume to have taken place at that time when the general deglaciation had proceeded so far would undoubtedly also have increased the tendency of stagnation in the glacial regimen.

Subglacial meltwater streams no longer entered deep ponded waters but after emerging from the glacier worked their way toward lower topographic points. A depression such as the Temiscamie River valley must have been a great collector of the meltwater and heavy loads were brought in and deposited in the valley. To what extent this occurred already in subglacial conditions is a difficult thing to estimate; in any case some of the meltwater chanelling in the Bethoulat Lake area seem to refer to subglacial activity.

My interpretation is that the Temiscamie River valley outwash fill is a direct continuation of the »Mistassini giant esker». The change in deglacial conditions is considered to be the factor responsible for the different morpho-

logical forms of the stratified drift. Thus there is no need for the hypothetical upland ice sheet; the phenomena in question are easily explained as the normal results of the sequence of events leading to deglaciation.

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ACTA GEOGRAPHICA 16, N:o 4

AMENITIES AND THE NOTION OF PERMANENCE IN SCHEFFERVILLE, QUEBEC

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MONTREAL, CANADA

HELSINKI
1958

PRINTED BY TILGMANN
HELSINKI 1958

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INTRODUCTION

A little more than twenty years ago, the first concessions to the iron-rich country of the central part of the Labrador Trough, in the heart of the vast peninsula of Quebec-Labrador, were granted. With the end of the second World War, the growing need for iron ore led to the beginnings of exploration and development in this region.

The first major step in the extraction of ore from the Knob Lake district was the construction of a single-tracked railway from the deep-water harbour at Seven Islands, on the Gulf of St. Lawrence.

This was begun in 1950, and completed in the spring of 1954. The construction of this railway, completed in the face of difficult topographic, geological and climatic conditions, was supplied entirely by air.

The settlement needed to house the workers and their families required the finding of a well-drained site which was conveniently close to the mining areas. A site was chosen at Burnt Creek, and a small company town with its wooden houses and company food commissary grew up rapidly. Within a short time, a chance drilling in the town revealed that it lay on top of a rich deposit of ore. As a result of this, the settlement was re-located on an accumulation of fluvioglacial sands and gravels on the edge of Knob Lake. It is at this site that the most significant social development has taken place, the most important part of which is the company town of Schefferville.

The establishment of a population of some 2,500 persons on a neck of land between the shores of Pearce and Knob Lakes was a direct response to the economic need for the rich iron ores of this part of the enormous peninsula of Labrador-Ungava (fig. 1 & 2). The story of the original settlement at Burnt Creek, the building of the railway from Seven Islands and the formative days of the »company town» has been told many times and has become almost a

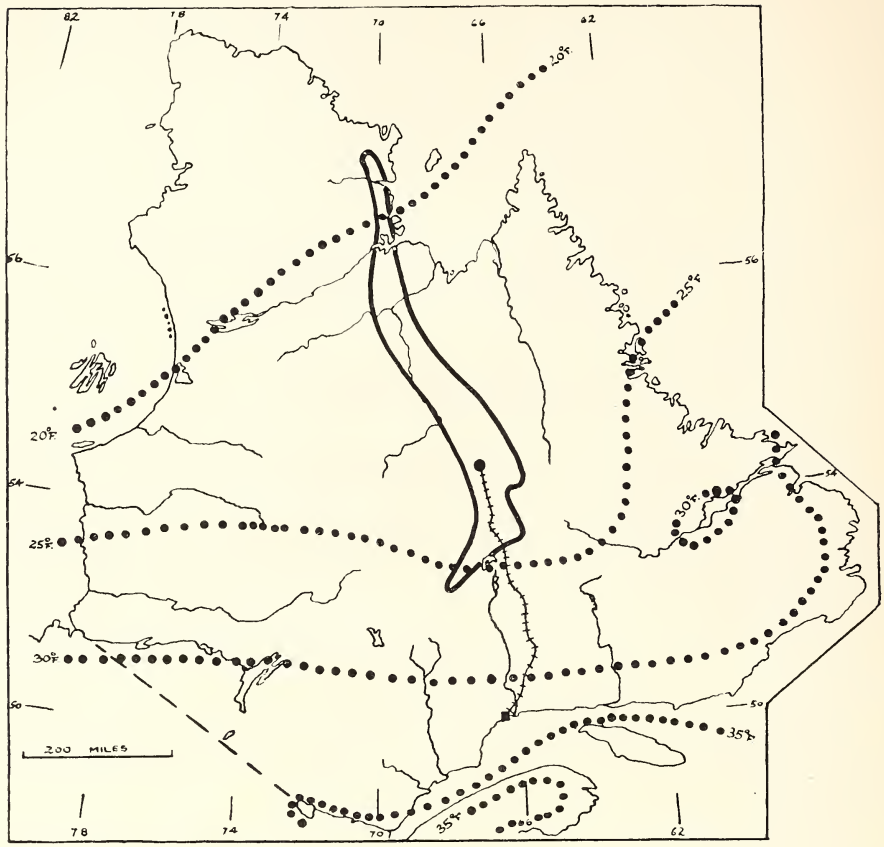

Figure 1. The location of the town of Schefferville (large dot) in the central part of the geological province known as the »Labrador Trough» (marked by the heavy line). The annual mean temperatures, in degrees Fahrenheit, are also indicated. The iron-ore port of Seven Islands, the southern terminus of the railway, is shown (large square).

legend.[1] The special significance of the Knob Lake venture, however, lay in its new approach to the specific problems facing the industry which seeks to win its raw materials in an Arctic or Subarctic setting. Difficulties of northern transportation had been met before and overcome — witness the Alaska Highway and the White Pass and Yukon Railway — but it was the question of labour supply which demanded an equally bold approach, for Knob Lake could not exist as a bunkhouse community as it might in a more accessible, and climatically temperate, region. The policy which was decided upon was

[1] See, for example, Ross, W. Gillies, 1957.

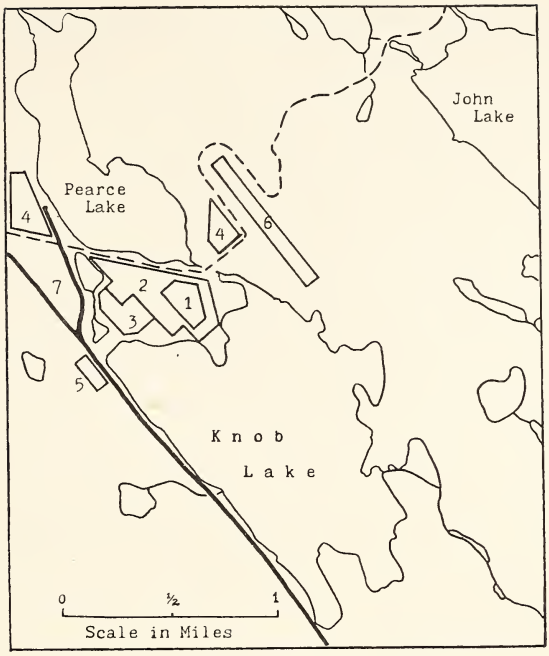

Figure 2. The functional divisions of the settlement of Knob Lake. 1 = Church and school zone; 2 = Housing zone; 3 = Commercial and shopping zone; 4 = Bunkhouse areas; 5 = Quebec North Shore and Labrador Railway station; 6 = Airstrip; 7 = Storehouses, wharfs, repair sheds, and offices of the Iron Ore Company of Canada. The Q.N.S. & L. railway is marked with a heavy line. The broken line indicates the main track-road. The town of Schefferville is composed essentially of units 1, 2, and 3.

one which encouraged technical workers to bring wives and families north with them, thus forming a nucleus of trained, technical staff of non-seasonal character. The hourly-paid worker who, largely because of his type of work, was necessarily of a seasonal nature in the climatically severe environment of Knob Lake, was not offered such encouragement. This policy has been regarded as economically sound.

THE BUNKHOUSE GROUP

The technical staff, together with their families, inhabit the newly erected town of Schefferville, living in houses of uniformly good standard and pleasing appearance. For some, the accomodation is more than they could have expected to secure elsewhere, whilst for others it is a welcome improvement upon city-apartment living. The non-technical, or hourly-paid workers, live in bunk-

houses, where conditions are adequate but no more. All unmarried workers eat in the company cafeteria, a standard charge being paid for the privilege.

This decision was based on the acknowledged difficulty of retaining labour for any length of time in extractive industries in the north. Officials recognise a definite »bunkhouse type» of man who is thought to be good material but difficult to retain. He is traditionally foot-loose, often a wanderer by nature and one who has usually had many more jobs than he declares at the time of his engagement by the company. There is also thought to be a sprinkling of individuals who come north to escape either the law, marital difficulties and embarrassments, or both. But by far the strongest attraction for this group is the amount of money which can be earned in a comparatively short time. Though by no means the quickest money to be had in the north, especially when compared to the rates paid to the men on the Distant Early Warning defence line, the company deliberately pursues a policy of high hourly pay with the opportunity of overtime, in an effort to maintain its required minimum labour force of 1,500. The bunkhouse accomodation is acknowledged to be extremely poor, the official attitude being that in view of, firstly, the type of man housed in it and, secondly, the commonly short sojourn of the average worker, the provision of quarters of more ample and pleasing dimensions would be both an excessive outlay of money and a gesture which would yield no improvement in the class of worker coming to Knob Lake. The »Quebec-Labrador Pioneers' Association», an establishment where beer may be bought and consumed, is patronised almost exclusively by the employees from the bunkhouses. However, activities in the town of Schefferville are often open to their participation and the various formal societies make attempts to attract their membership with, however, limited success. Only in the realm of team games does any advance seem to have been made in this direction and, even here, only an estimated twenty percent of the men participate.

There exists here, then, the common phenomenon of a large body of male workers ignoring or, at least, lacking a positive response to the several amenities which are placed before them. When quitting Knob Lake and asked for their reasons, men conveniently quote monotony of food or poor accomodation, but, while these two factors cannot be ignored in many cases, the true reasons must be diverse. Loneliness, plain and simple, is a very real cause, though there are few men indeed who would quote this in so many words. It commonly takes the form of »sick of this place» or just »fed up». The almost complete lack of normal social and sexual expression undoubtedly places a great strain on the individual, the numerical superiority of the group rendering any normal

social response impossible. This is the root of the »fed-upness» which most confess and many flee from. It is a malady of many northern establishments. Too often, also, it is the individual with poor emotional resources who finds himself a member of a bunkhouse. As McCollum notes in speaking of Alaska ». . . without question, the poorest risk in terms of productive efficiency in the environment described was that individual commonly known as the »psychopathic deviate», the person who demonstrates a lack of deep emotional responses, the inability to profit by experience, and a disregard for the accepted social mores. These persons incessantly rebel against the limitations imposed upon them and express this rebellion in a variety of anti-social media.»[1] The rebellion, as far as Schefferville is concerned, is expressed in their demand for the termination of the employment contract after, on the average, only five or six months. Leaving aside this type of person, McCollum [1] states that the bulk of the trouble arising with psychologically ill-adjusted persons could be avoided by brief but thorough preparation of individuals before their move north. Especially for unaccompanied workers, selection on a basis of temperamental suitability for work in the north and life in a socially unbalanced community is the only sound method for reducing turnover of manpower. This is practiced in some armed forces at present. Whether it is economically possible for a single company to do this for each individual is very questionable, especially in view of the drastic reduction in the numbers of hourly-paid workers (approximately thirty percent) at the end of the ore-carrying (summer) season. However, an interesting recent development, directed towards some method of recognising the types of men who stay with the company for the longest time, has been begun in Schefferville as a sub-department of the Iron Ore Company's personnel department. It is too soon to expect results, but preliminary examination of the first interviews of men leaving the company has shown that, as might be expected, loneliness is a basic cause. Bunkhouse men, on the whole, rarely quote the severe climate as a deterrent to their staying in Knob Lake. Few winter workers, indeed, come into direct opposition to the elements in that mechanical shovels, Euclid trucks and such tools are generally heated, and it has been stated categorically by an executive that, though the efficiency of machines may begin to drop at minus 30 degrees Fahrenheit, the efficiency of the men remains relatively unimpaired. Scientific investigation of this, however, might produce interesting results.

In addition to the bunkhouse group is the staffhouse group of technical and secretarial workers. A staffhouse for women is incorporated into the

[1] McCollum, Ernest L., 1952.

town estate, while the staffhouses for men are in the same group of buildings as the bunkhouses and of the same general appearance. This single salaried group lies in every sense between the population of the bunkhouses and that of the townsite. They are of a higher mental status than the general run of bunkhouse personnel but lack the home life found in the town. They are salaried and live in the equivalents of bunkhouses. They are, accordingly, able to prevent themselves from succumbing too easily to the low spirits springing from the lack of normal social relations. However, the overall attitude of the group towards the notion of permanent residence is naturally similar to that of the bunkhouse men and for broadly the same reasons.

Though the list of amenities offered to the population of Schefferville is possibly more complete than would be found in many northern towns, it is thought that it has little effect upon the working life of the unmarried man in Knob Lake. Only a normal increase in the amenities as a result of the stabilization of population and the consequent establishment of normal or near-normal age and sex ratios will affect the bunkhouse turnover. This is precisely what has happened farther south and the possibility of its happening in Schefferville is very much a question of the future quality of the community housed in the townsite.

THE TOWN GROUP

The townsite of Schefferville represents the greatest effort of the Iron Ore Company of Canada in the realms of personnel and labour relations. It was an effort implicit in the large design of extracting iron ore from the centre of a landmass of sub-continental size. The fact that it was the creation of a single company made the planning as sound and well-timed as any project of its kind. The town has been carefully sited and is being built well and surprisingly quickly. The small nucleus of the housing area is a series of about a dozen small, compact »shacks» dating from the Burnt Creek period. They are still lived in and form the only example of a division in the standard of the housing. As soon as sufficient housing has been built, this small group of older houses will be removed. The houses erected by the company for their employees are of four main types — single floor, detached; two floor, detached; semi-detached, two floor; and four-in-one duplexes. All are of wooden construction with concrete basements, and all are colourful and well lighted (figs. 3 & 4). Streets are laid out in crescentic form with straight, intersecting cross-streets. These houses, together with the bunkhouses, were the first

Figure 3. General view of the south end of the town on the edge of the commercial zone. The service station seen on the right provides fuel and repairs for all vehicles except those used in the mines. Some single-tenant bungalows can be seen on the left of the picture. Note the newly-laid sidewalk in the foreground. Knob Lake is in the right background.

requirement for the settlement and the most important amenity as far as potential married workers were concerned. Houses continue to be built so that families can continue to move into residence. Essential hourly-paid workers, who have remained with the company for some time, live in houses. It is maintained that the houses are not strictly for salaried men though, of course, this group must always be in the majority in this respect. A sign on one of the older dwellings announces, »J. M. Lapierre. Shovel Operator.» with a frankness and, perhaps, pride which is now largely discreetly curtained by the uniform, freshly-painted front doors. A large Roman Catholic church, completed as early as Christmas 1955, a school, and the foundations of another church formed the original core of the settlement. With the establishment of a bank and a general store, a business section was begun and the town took on the characteristic layout of most planned settlements of the Western World. A cinema followed and the erection of a Hudson's Bay Company store (food and general) and the addition of a food section to the general store completed the business section and marked the end of the strictly »company town» with its subsidised food commissary. A restaurant now functions in a basement and is in process of expanding above ground, whilst a small hotel has recently been opened. A federal post-office has been set up after much effort, and letters coming in daily by air arrive much more promptly than was the case when mail arrived only twice a week by company transportation. In the twelve months from July 1956 to July 1957 Schefferville outgrew its status of bush mining settlement and became an established, though immature, provincial

Figur. 4. One-family housing in Schefferville. The street names are exclusively of local origin, many taking the names of near-by lakes such as the one shown above.

town. The town is immature in two respects: firstly, its social structure is lop-sided and, secondly, its range of amenities is good but severely restricted. With the alleviation of the second difficulty, the first may be expected to dissolve over a period of years.

The resident population of the townsite originated largely in the Montreal-Quebec City region or similar industrial-urban areas elsewhere in Canada, the United States and Europe. Although outside entertainments are an important part of modern city life, the family group, even today, tends to spend much of its leisure time either together or with another family group in the home. It is, in effect, less dependent upon »artificial» amusements than unattached persons such as are found in the bunkhouses and staffhouses. This group will, therefore, tend to be less dominated in its attitude to the idea of a permanent stay in Knob Lake by the presence or lack of amenities such as the cinema or television than might be the case with unmarried people who lack the home atmosphere.

As in most small towns, the families have organized themselves into a series of formal associations. The primary associations are the Roman Catholic Church wich fosters several secondary associations including a troop of the Scouts Canadiennes; the United Church of Canada which is parent to a women's

guild and to some smaller groups, such as the annual Minstrel Show, which are of a seasonal nature only; the Iron Ore Company which encourages such groups as the Knob Lake Mining Club for the discussion of topics related to mining: and the several leagues which bring together teams sponsored by the various industrial and military concerns. The school is not a primary association as it commonly is in towns throughout North America. There is little support for a youth organisation, partly because of the relatively small number of pupils and also because »they're with one another all day, they hardly want to be together two or three nights a week.» A troop of the Boy Scouts Association of Canada has been established recently, however, and is slowly expanding. There is no parent-teacher association and no move has been made to create one. A branch of the Canadian Legion flourishes while within the working group there is a labour union, the Schefferville Iron Miners Association.

Despite this list, and considering the population of the town, the formal association is poorly developed in Schefferville. When asked what clubs and associations existed in the town, many married couples gave an incomplete list and ended by saying they were not »club types». This paucity of formal associations, as indicated by very many conversations and observations, is compensated for by the moderately strong development of the informal association or »clique».[1] Individuals have distinct small circles within which they normally move in the day-to-day social round, though occasionally an evening will see the combination of members of two or more cliques through the medium of members held in common. Activities range from Bridge evenings to dinner parties. Single-sex cliques are most commonly female and owe much of their stimulus to daytime (»working hours») contact. All-male cliques tend to develop around commonly pursued sports, especially fishing. There is a definite feeling that social groupings and activities are restricted in the town. Certainly, choice of social affiliation is very much smaller than in a middle class section of suburbia, where the presence of the rest of the family (in the broadest sense) immensely expands the social »reach» of the individual family group. The varying complexity and organisation of the informal associations with the quite sudden change from severe winter conditions to the long days of summer would be an interesting study, though an admittedly difficult one. Unlike the formal associations in Schefferville, the informal ones are cast within an incipient, though definitely recognisable class structure. Social classes are though to be reflected more directly than might be the case in a more open society by the financial scale. However, the classes are both less numerous

[1] A good discussion of both formal and informal associations can be found in LUNT, WARNER, 1941, chapter XVI.

and more difficult to distinguish than in the usual urban group. Across this »horizontal» stratification lies the complicating »vertical» division between the Roman Catholic, French-speaking element (approximately 75 percent of the town population) and the Protestant, English-speaking element.[1] This »vertical» division is by far the strongest, and may account for the somewhat retarded stage of the development of a class system. There is a suggestion of a further »vertical» division within the Protestant group on the basis of differing religious affiliations. Six classes are commonly distinguished in both urban and rural environments — upper-upper, lower-upper; upper-middle, lower-middle; upper-lower and lower-lower [2,3] — and five have recently been established in Great Britain on a basis of occupation.[4] Schefferville has no representatives of the upper-upper, while most of the upper-lower and all of the lower-lower are probably non-existent or partially compensated for by the large male labour force of the bunkhouses. This, then, is essentially a middle-class town (the two middle classes may represent 85 or more percent of the population) which stamps it as more characteristically suburban than either urban or rural. The attitude towards social behaviour — »respectability» —, to the arts, entertainment and the basic requirements for the conducting of their lives in both a comfortable and a rewarding manner, are distinctly middle-class.

It is believed that such a group of people are equipped to achieve the adjustment to the differences between life in Schefferville and life in a southern suburb, but with certain reservations. As the town as a unit is dependent on southern Canada for everything it consumes, so the housewife is dependent on amenities not yet found in Knob Lake. For instance, shoes for mending and goods to be dry-cleaned must be sent to Seven Islands. Also, the Anglican minister had to travel up to Knob Lake periodically until a permanent minister was appointed in the summer of 1957. It is not possible to buy fresh bread in Knob Lake, for there is no bakery, bread being imported from Seven Islands and Matane. Fresh milk, also imported, immediately doubles its price. However, these factors do not loom large in the mind of the average housewife. More often quoted is the lack of a resident optician and dentist (especially to serve the needs of the children) and the limited facilities of the hospital and staff. Further, as GARRY points out of Chibougamau ». . .les magasins étant encore peu nombreux et insuffisament achalandés, les achats se font sur

[1] GARIGUE, P., 1957. This article contains an interesting discussion of the problems of integration facing the French-Canadian in Schefferville.

[2] LUNT, WARNER, 1941, loc. cit.

[3] WILLIAMS, W. M., 1956.

[4] COLE, G. D. H., 1955.

catalogue des grands magasins de Québec ou de Montréal.»[1] In this respect Knob Lake is truly suburban to Montreal and it is difficult to see how it can ever be otherwise.

MATERIAL AMENITIES

In other discussions of mining towns built in marginal areas there is a strong emphasis placed upon the importance of material amenities in relation to the question of permanence. GARRY's report on the Chibougamau of 1953 clearly shows the quality of the Knob Lake achievement in material terms. Stating that there existed no telephone connection or rail link at this time, he goes on to say ». . . Les seuls éléments stables se rencontrent dans l'agglomération où une vie urbaine se développe peu à peu.»[1] The early telephone link between Montreal and Knob Lake and the already mentioned rail link is a tempting comparison. The colourful mining venture (copper, zinc and lead) at Huarón in the Peruvian Andes provides a comparable example of a mining company combating conditions which are discouraging to natural settlement with a bold policy in terms of the supply of amenities — »La Compagnie des Mines de Huarón s'est attachée, par les réalisations sociales qui lui font honneur, à rendre à chacun la vie supportable et même, pourrait-on dire, agréable.»[2] At Huarón three butchers provide fresh meat. It is interesting to ponder on the different response found in Schefferville in a population completely conditioned to the idea of neatly parcelled, frozen meat and fish. Huarón boasts, for a working population of 7,000, a fully-equipped hospital, two surgeons, one dentist, four schools and two churches, as well as popular social and sporting clubs and stores which supply anything from a sewing machine to a radio set. The similarities to Knob Lake, rather than the differences, are very striking.

»It might be said that there can be no permanence of white settlement in northern North America without good transportation.»[3] The quality of the transportation between Montreal and Knob Lake is a definite bolster to the notion of permanence. Daily flights by Quebecair Inc. bring mail and freight, the charges for the latter being responsible for the scarcity and high prices of certain items. Twice weekly the aircraft of Hollinger-Ungava Transport (a subsidiary of the Iron Ore Company) bring company personnel and supplies,

[1] GARRY, R., 1955.
[2] GARRY, R., 1956.
[3] STONE, Kirk H., 1955.

while the bi-weekly rail-haul is accomplished to supply the town with its food and other bulk requirements. Freight and passengers are carried by rail slowly but cheaply. However, the restriction upon easy local movement is felt and commented upon. Although there are many private cars, a taxi and a'bus service, and many men have the opportunity to use their company »pick-up» trucks, the roads open to the public are few in number and small in total mileage.

While the question of material amenities is one which must be carefully considered in any attempt to estimate the stability of a population in northern locations, the greatest single factor which, time and again, plays such a large rôle is the weather. ULLMAN has, with considerable justification, included climate under the general heading of amenities — ». . . Climate is probably the most important regional amenity . . .»[1] — and one which exerts a considerable effect. As far as living in the north is concerned, climate inevitably acts as an amenity in the negative sense — in other words, it is rarely neutral and usually a deterrent. MCCOLLUM observes ». . . probably the most forceful common factor in determining human behavior in most of Alaska is the weather. In large areas a great proportion of one's time in the winter must be spent combating the elements. The difficulties of transportation, labor, amusement, etc., are multiplied by the sub-zero temperatures, the deep snow and the long hours of darkness.»[2] Similarly, many individuals, though always stressing that they were not unhappy in Knob Lake, spoke nostalgically of autumn colours, the luxury of sitting outside during the long summer, and the desire to escape the apparently unceasing winds of the northern winter. A common adjunct to such sentiments was the direct expression or the suggestion that the environment was not completely acceptable because of its »abnormality» in the minds of many. In this connection, perhaps, was found the strongest rejection of the notion of permanence on the part of the individual.

OTHER INDUCEMENTS

The quality of a town is the direct reflection of the quality of its inhabitants. It is appropriate to question the probable motives which acted to bring a group of more than 2,000 people together into a settlement at Knob Lake. Economic opportunity is the traditional motivating force of past migrations, small and large, and economic advance is the obvious prize to many who

[1] ULLMAN, EDWARD L., 1954.

[2] MCCOLLUM, ERNEST L., 1952.

have come northward, especially since 1945. Of the many who migrate in the search for greater material reward, there are often a few who might be called »pioneers». Whilst no hazard is made at the present virility of this breed, Knob Lake probably owes but one percent or less of its population to this motivation. »The 'Go west' of the early 1900's is not necessarily the 'Go north' now . . . the days of the 'boom' population may be over for possibly the whole region.»[1] Many of the technical staff were undoubtedly moved to come to Knob Lake to enlarge their experience in mining. For most it is probably fair to say that a mixed motive existed. It is from this group, perhaps, that the »oldest inhabitant» of Schefferville will finally emerge. The bunkhouse group have two additional motives, both of which have been referred to, namely, the desire to escape responsibilities or embarrassments and the unguided wish to »move on» from one job to the next after only a short stay in each.

Of all these inducements, the financial one is demonstrably the strongest. That it is not completely successful in maintaining the labour force is known, and witnessed by the great labour turnover. It is suggested that, while financial advance will always remain the chief factor in drawing labour to Knob Lake, the major factor in retaining that labour will be the presence of amenities in the broadest sense of the word. As Ullman observes ». . . The new 'frontier' of America in thus a frontier of comfort, in contrast with the traditional frontier of hardship.»[2] In the case of northern settlements the comfort frontier, leaving aside the negative quantity of the winter, will have to include, as well as material comforts, a society which is stable as a whole and complete in all its several parts. It will take everything which the middle-class mind regards as »normal» to counteract the ingrained conviction that ». . . where one was born and lives is the best place in the world, no matter how forsaken a hole it may appear to an outsider.»[3]

CONCLUSION

In conclusion, it may be said that Schefferville is endowed with a wide range of improving material amenities which are thought to lengthen the period of residence of a worker and his family. It is clearly at the same disadvantage as most northern mining settlements, however, in that, firstly, its climate definitely detracts from its power to retain its labour and, secondly,

[1] Stone, Kirk H., loc. cit.
[2] Ullman, Edward L. loc. cit.
[3] Ullman, Edward L., loc. cit.

the conditions leading to a normal social structure do not, and probably may never exist in the town. These two factors acting together are thought to be extremely formidable in their effect upon the attitude of the average resident to the idea of remaining in Schefferville permanently. With the great reserves of iron-rich sediments assured, no doubt there will be a settlement at Knob Lake for many generations to come. However, it is difficult to prophesy whether there will be a marked permanence of family units as distinct from a shifting, semi-permanent population. Certainly, the notion of permanence is poorly developed at the present time, though it has taken root in some minds. Its growth and acceptance will depend largely upon the establishment of a normal social spectrum.

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Edit. by A. Tammekann

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Text 205 pages, 66 figures in the text, 5 plates.